1954 LONDON SHOW REVIEW

AUTOMOBILE ENGINEER

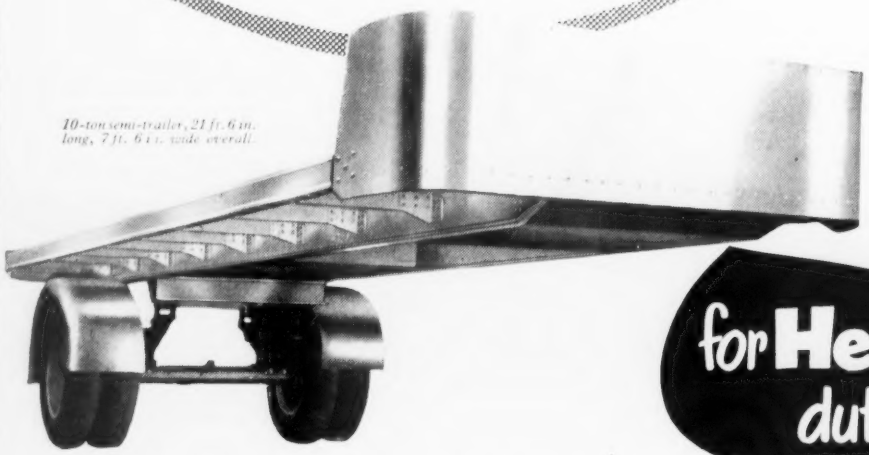
DESIGN · PRODUCTION · MATERIALS

Vol. 44 No. 12 NOVEMBER 24, 1954 PRICE: 3s. 6d.

Light trailers in

DURALUMIN

REGD. TRADE MARK

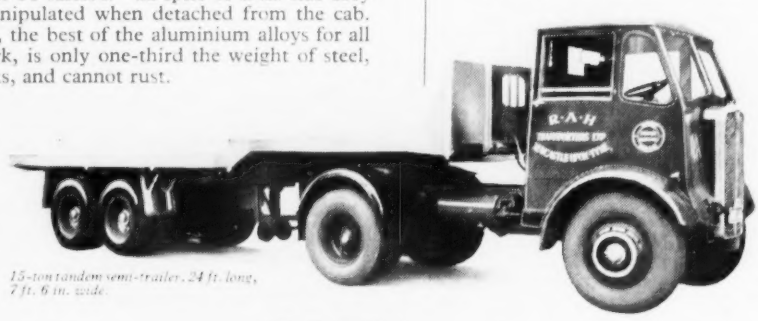


10-ton semi-trailer, 21 ft. 6 in. long, 7 ft. 6 in. wide overall.

for Heavy duty

These two robust trailers made in 'Duralumin' extruded section and plate by R. A. Dyson & Company Limited of 76 Grafton Street, Liverpool 8, will stand up to the heaviest duty with appreciable savings in operating costs. The light weight construction reduces tyre wear and fuel consumption while enabling a heavier load to be carried. In spite of their size they are easily manipulated when detached from the cab. 'Duralumin', the best of the aluminium alloys for all transport work, is only one-third the weight of steel, absorbs shocks, and cannot rust.

Our Development Department will gladly give all possible help, entirely without obligation, to those interested in the use of James Booth light alloys for transport or any other purposes.

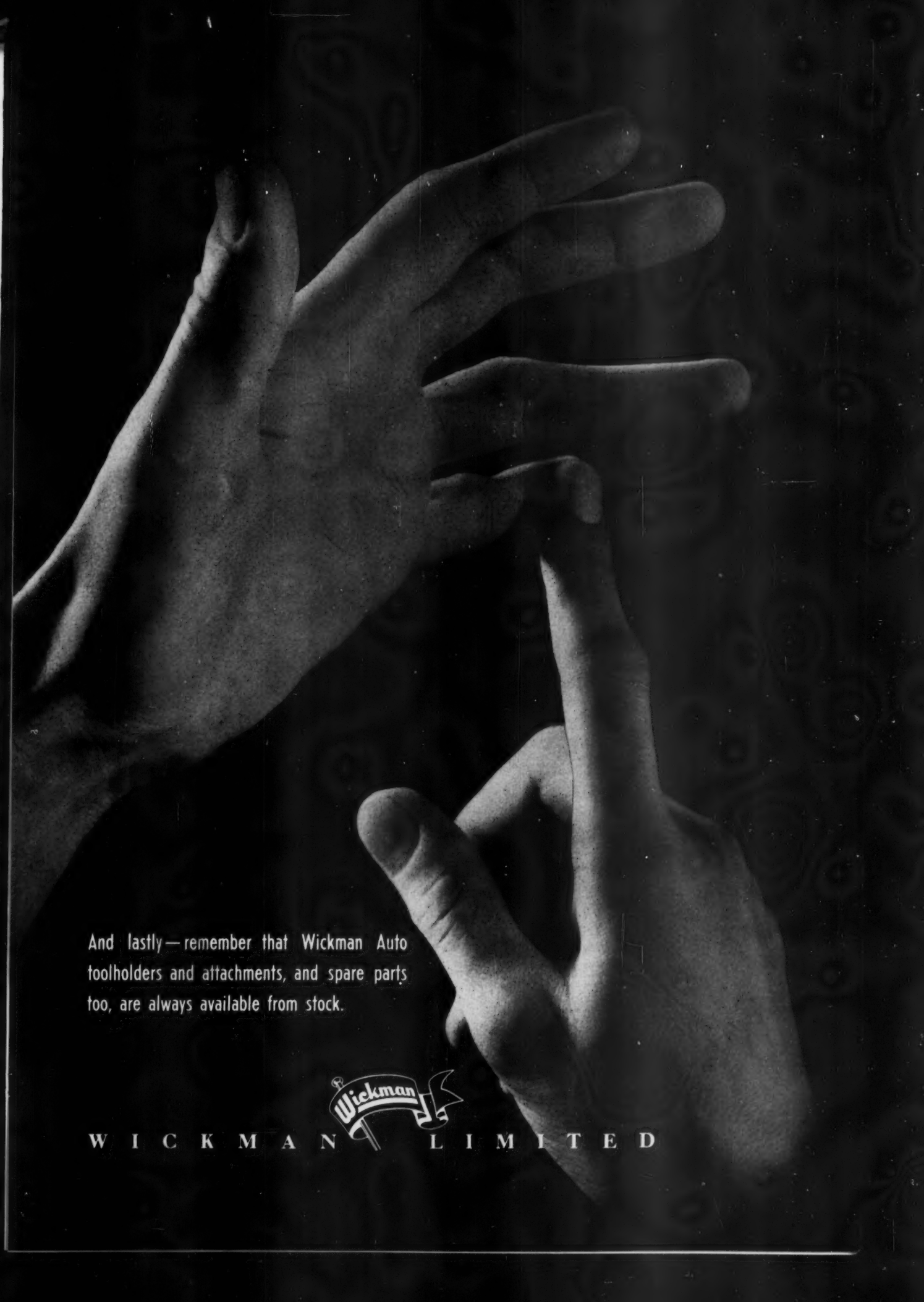


15-ton tandem semi-trailer, 24 ft. long, 7 ft. 6 in. wide.

JAMES BOOTH & COMPANY LIMITED BOOTH BIRMINGHAM ARGYLE STREET WORKS · BIRMINGHAM 7

RAD1

Mintex Brake and Clutch Liners are manufactured by British Belting and Asbestos Ltd., Cleckheaton, Yorkshire. All Mintex products are obtainable from Mintex Service Depots and Stockists throughout Great Britain and the world. B.B.A. are also the manufacturers of 'Scandura' the original P.V.C. fireproof conveyor belting.


And lastly—remember that Wickman Auto toolholders and attachments, and spare parts too, are always available from stock.
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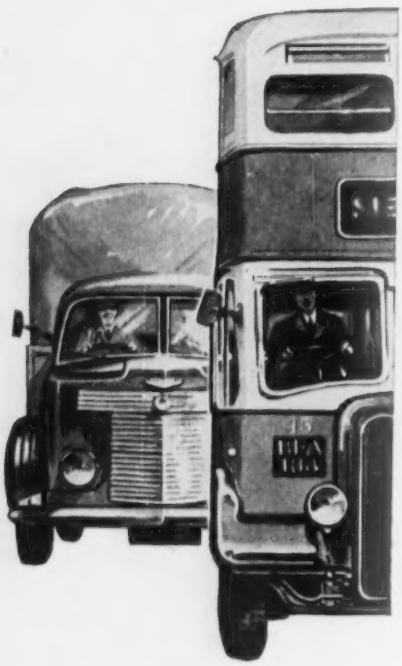
WICKMAN LIMITED

*'Syndromic' Automatic Lubrication

Soon pays for itself!

* GIVES YOU 10% EXTRA SERVICE FROM EVERY VEHICLE!



The 'Syndromic' system lubricates up to 80 bearings (using 2 pumps)—at periods automatically controlled by mileage—*while your vehicles are on the road!* In this way, hold-ups for lubrication are eliminated and you get as much as 10% more service out of your fleet at no extra cost. In fact, 'Syndromic' automatic lubricators are *more* economical. They save 75% on lubrication, reduce wear on bearings, etc., and therefore cut maintenance and replacement costs to a minimum.

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Ask for a Tecalemit technical representative to call and discuss the 'Syndromic' system with you.

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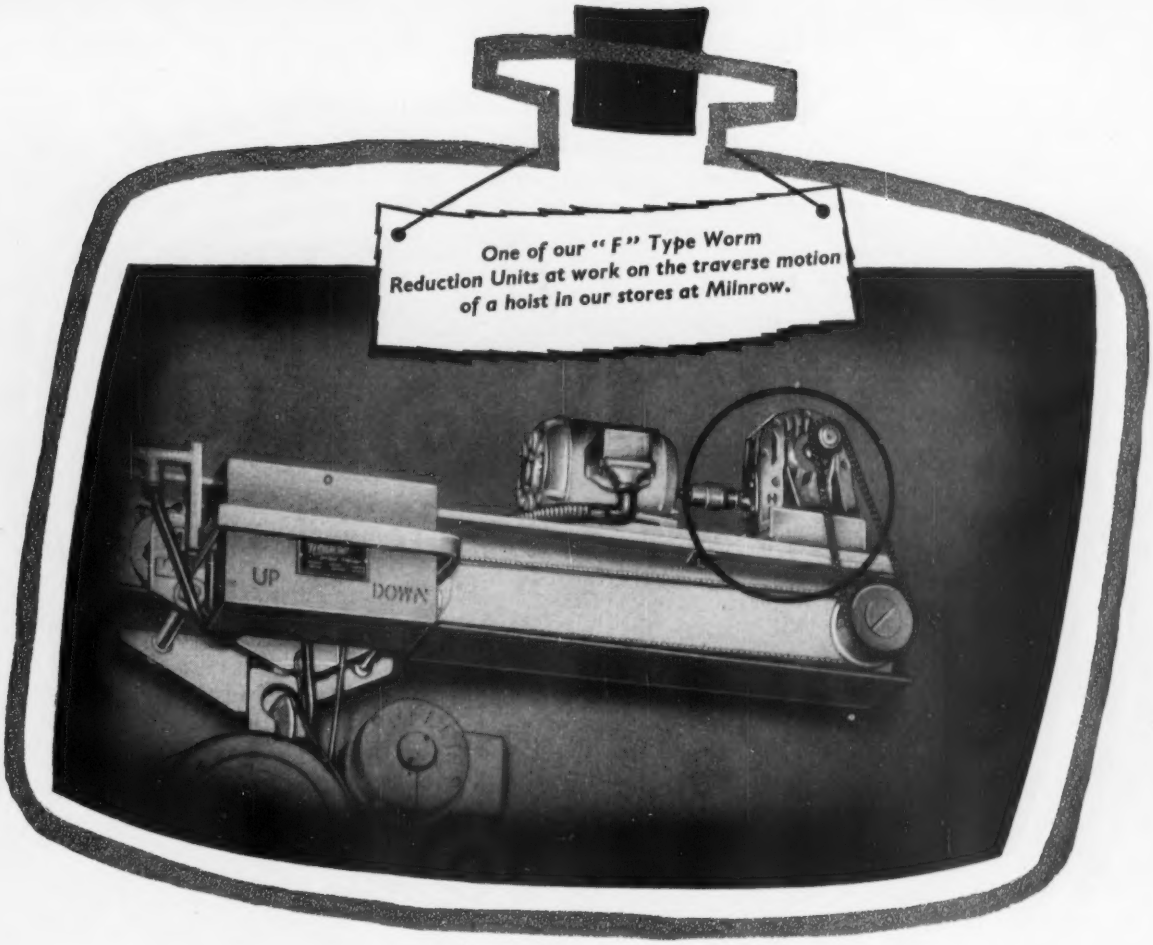

One of our "F" Type Worm Reduction Units at work on the traverse motion of a hoist in our stores at Milnrow.

Taking our own medicine

To see the way we use our own Worm Units all over our works you'd think we liked the taste of our own medicine better than Lancashire hot-pot. But it's just because these units do so many jobs so very well. Which is what you'd expect from their prescription—special metals, rigorous testing, and 50 years' experience. This formula can be . . .

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A Standard Type Holroyd Worm Reduction Unit with a stock ratio can be made up, packed and despatched to you within a few days. Special units or worms and wheels made to order take a bit longer. For information on our Worm Units, and on new applications for them (like the crane traverse gear in the illustration) drop us a line at Milnrow, Lancs. We'll be glad to help you all we can.

Holroyd WORM REDUCTION UNITS

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CRC 168

Having a hand in Productivity

Three men's hands

The one hand on the lever is about to make a small movement—and the battery electric fork-lift truck will pick up 36 crates, and take them to the waiting lorry. The electric truck will take the crates quickly, quietly, safely and economically. Without the truck, at least three men would have been needed, and the job would have taken them very much longer. There are electric trucks for handling all kinds of products, from reels of cable to molten steel; easy to drive, long-lived and economical, they speed up production, save time, save labour.

But the electric truck is

only one of the aids to higher Productivity that Electricity can bring you.

IN EVERY INDUSTRY OR TRADE, electrical equipment is the key to modern production methods. There are probably more production-boosting and money-saving devices than you know of. Your Electricity Board can help you and give you sound advice.

They can also make available to you, on free loan, several films on the uses of electricity in Industry—produced by the Electrical Development Association.

E.D.A. are publishing a series of books on "Electricity and Productivity". Four titles are available at the moment; they deal with Higher Production, Lighting, Materials Handling and Resistance Heating. The books are 8/6 each (9/- post free) and the Electricity Boards (or E.D.A. themselves) can supply you.

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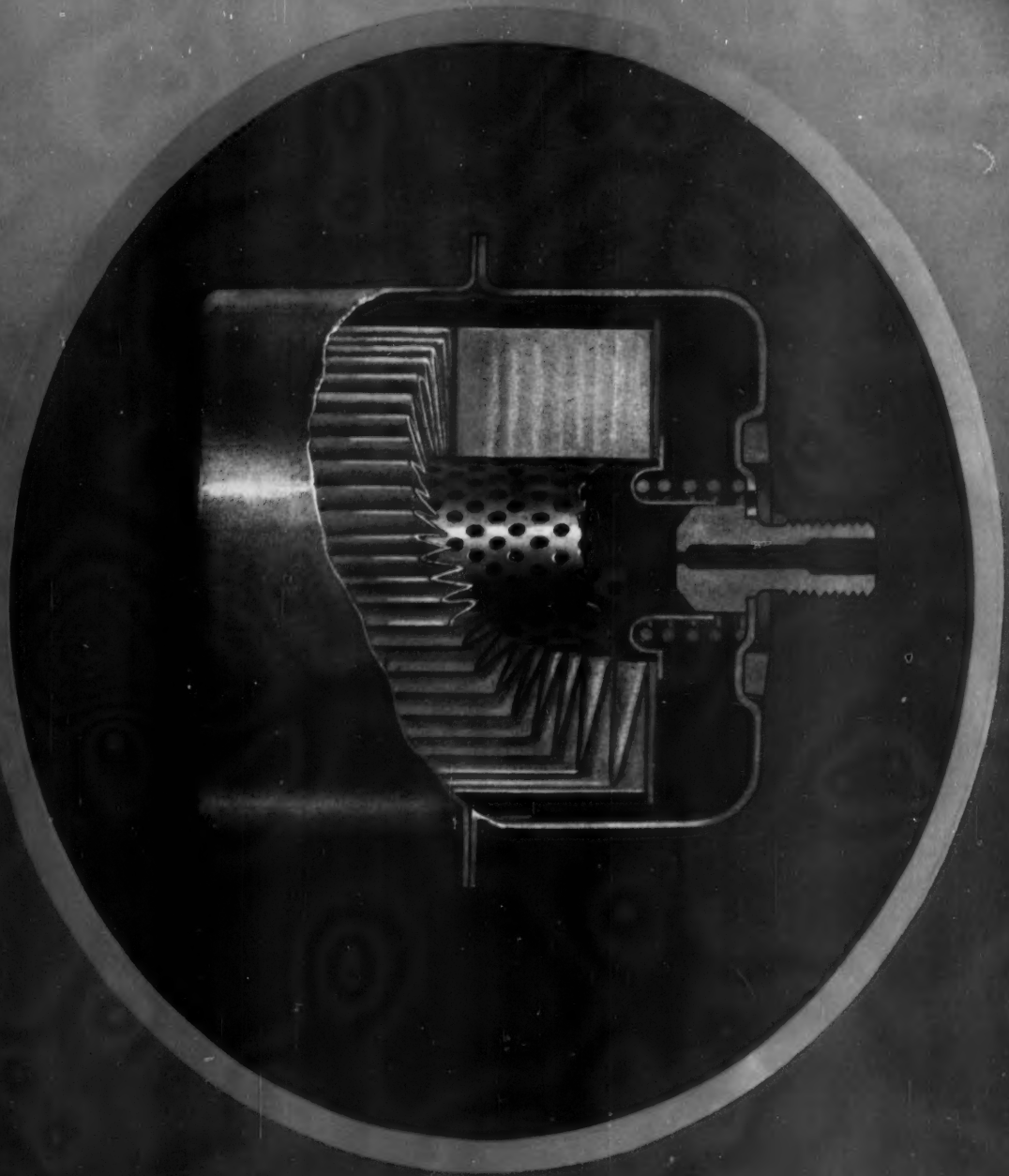
BRITAIN'S MOTOR INDUSTRY



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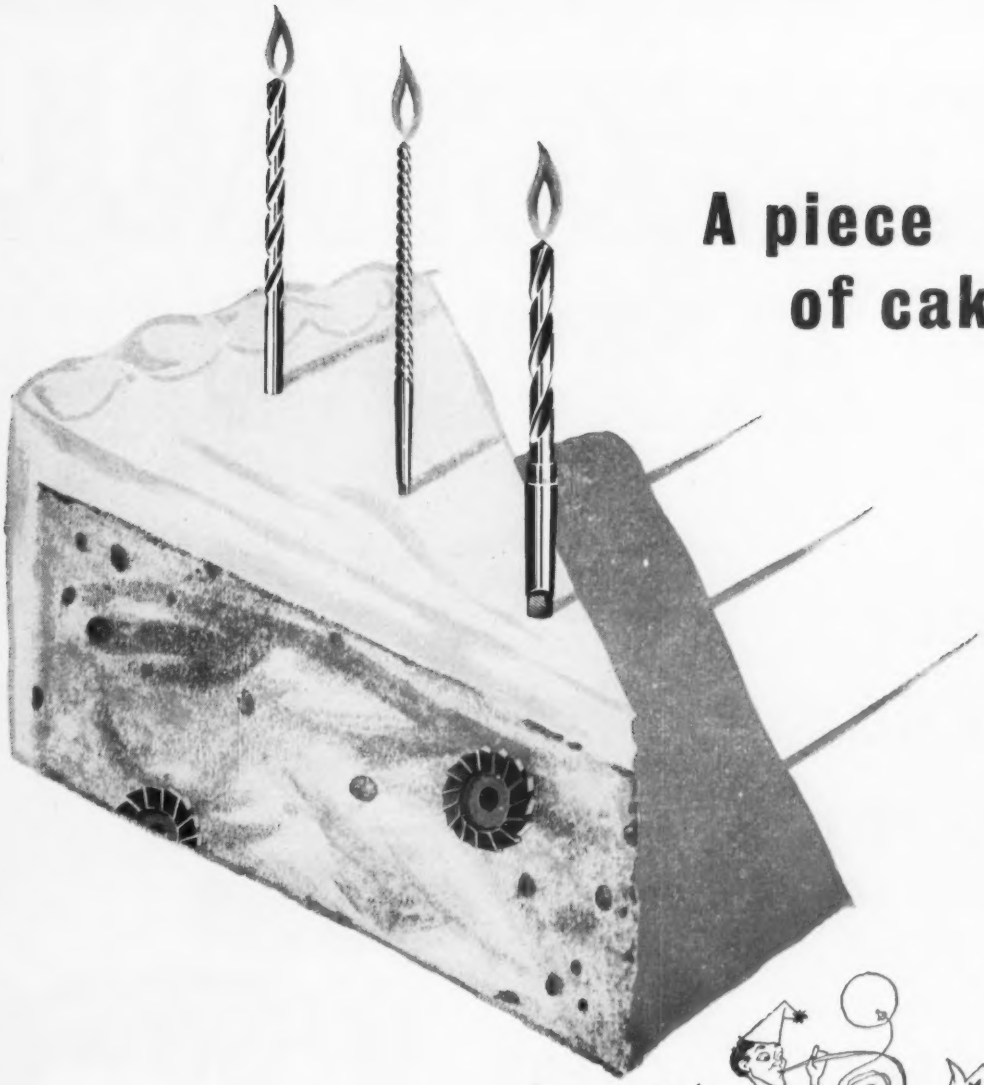

At first sight, wholly irrelevant, but those of us with growing sons know, only too well, the full import of the phrase . . . 'O.K. Dad —it's a piece of cake!' It implies, at once, absolute confidence, a certain facility for doing a job quickly and well. In other words . . . 'it's as good as done!' There's nothing more to add, is there?

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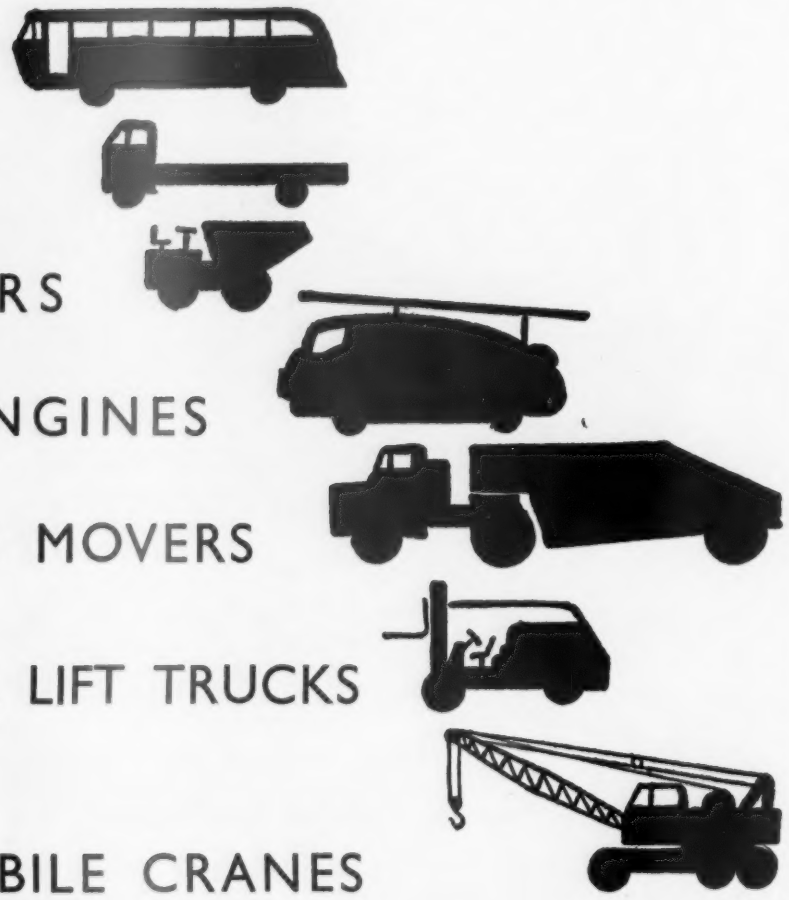

KIRKSTALL FORGE ENGINEERING LIMITED

LEEDS, 5

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F.P.1

Bees and Bats

EVERY NOW AND AGAIN, said the Managing Director, someone gets a bee in his bonnet. He wants to put a nut where no nut was ever put before, or drill a hole round umpteen corners in a place only a bow-legged dwarf could reach. What, my friends is the result? Production lines go haywire and foremen go berserk. Should we then send such a person to Coventry? Not so. We should send him instead to the Desoutter Works, where members of my loyal staff are lined up waiting to give him what he deserves—some entirely new small power tool which puts his idea into practice at positively no trouble to anyone.

This service, which we are happy to provide for those with bees in the bonnet, does* NOT *apply to those with bats in the belfry.

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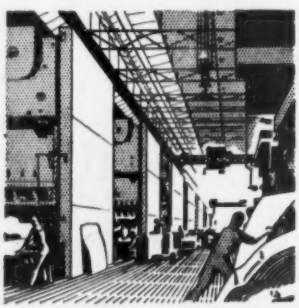

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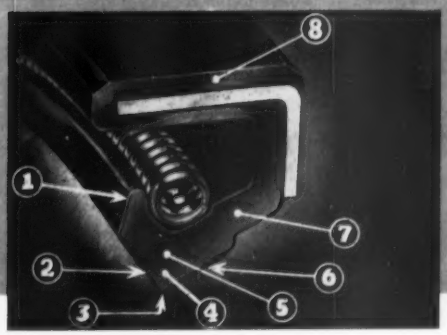

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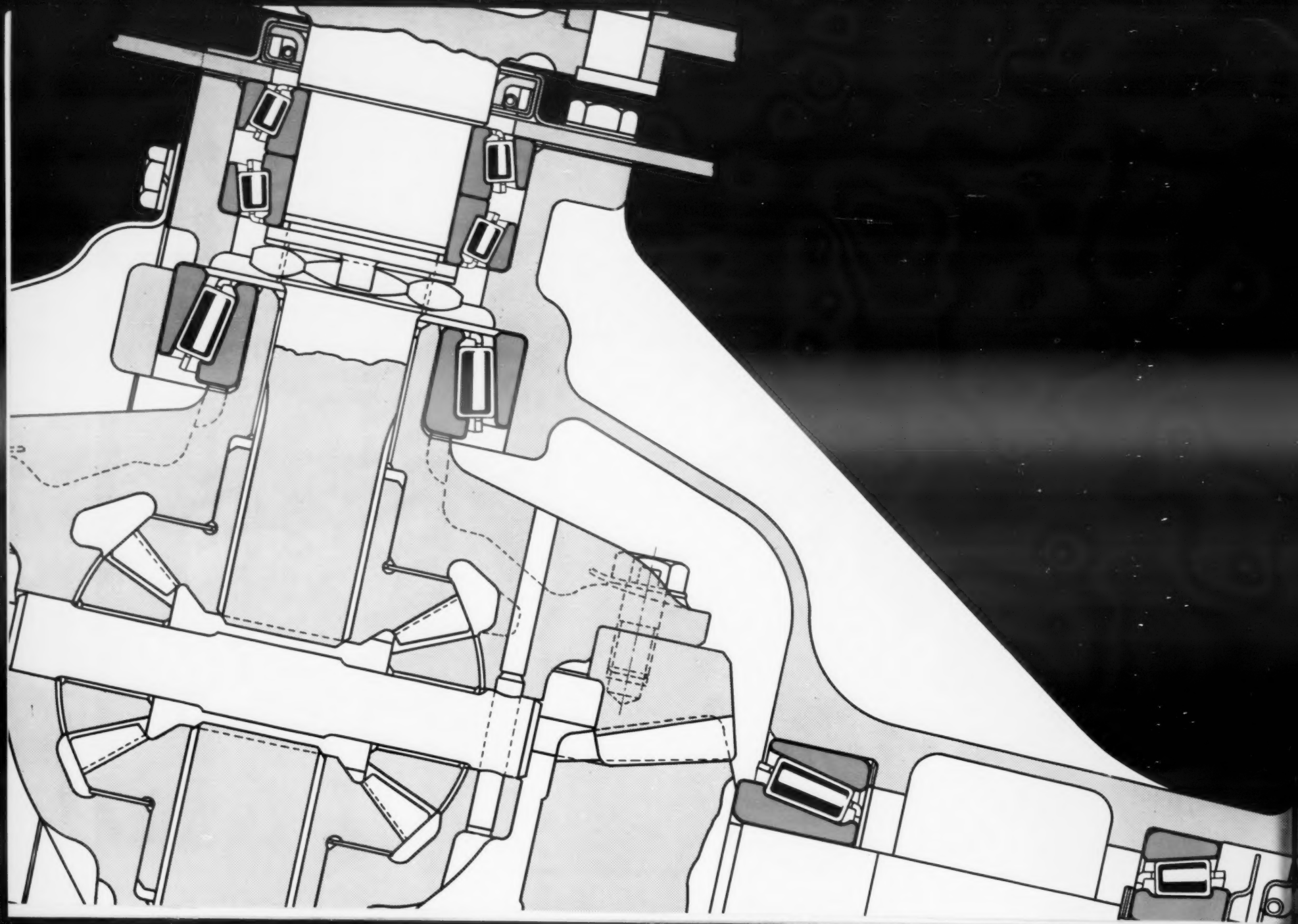

In a rear drive for I.R.S.

This interesting hypoid unit, for driving independently-sprung rear wheels, or wheels mounted on a de Dion axle, is made by Salisbury Transmission Ltd. of Birmingham.

It is suitable for handling 200 lb/ft. engine torque with a 4 : 1 low-gear box ratio. The final drive may be from 3 : 1 to 6 : 1.

The unit is fitted throughout with Timken tapered-roller bearings; the mounting of the differential shafts is of interest, giving excellent end-location against end loads, whether arising, as in some applications, directly from road wheels or, as in others, from the reluctance of splined joints to slide when transmitting heavy torque.

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tapered-roller bearings

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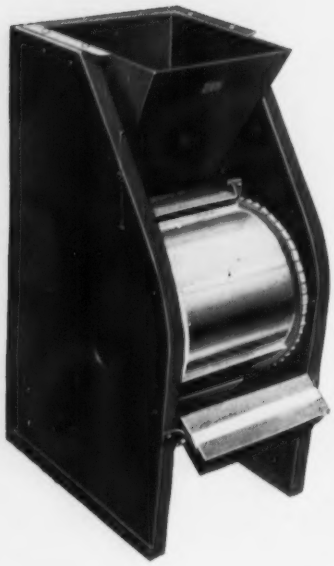
MAGCO CRACK DETECTOR UNITS can be *supplied* for every possible type of work.



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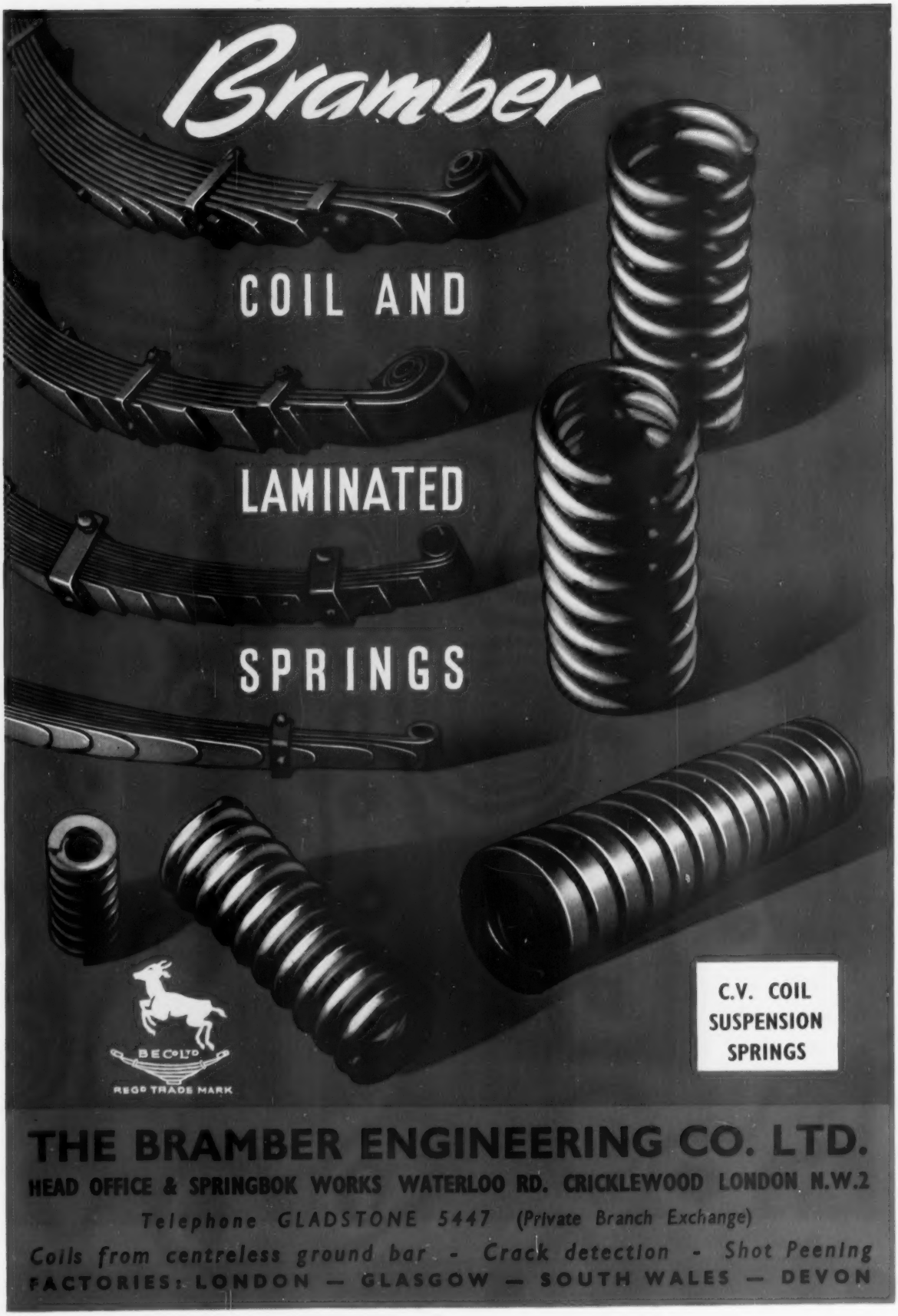

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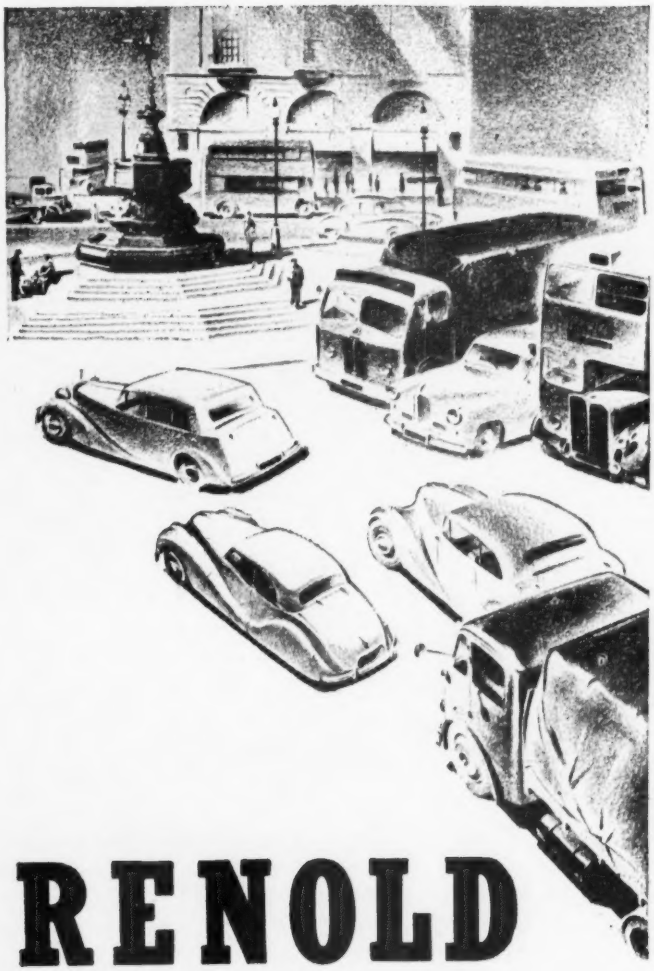

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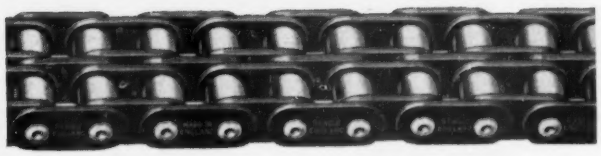

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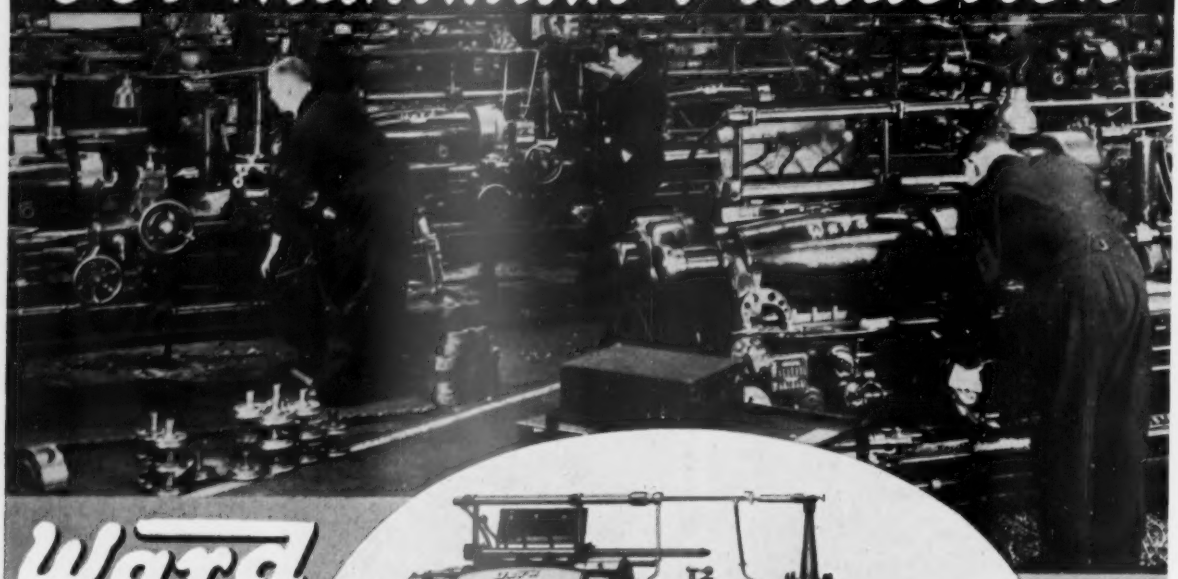

Ward No. 7

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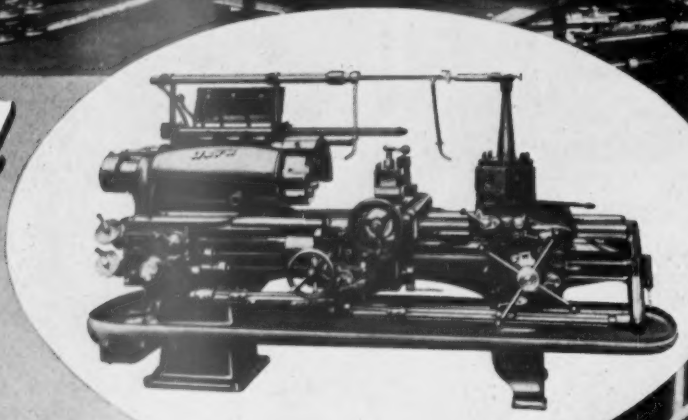
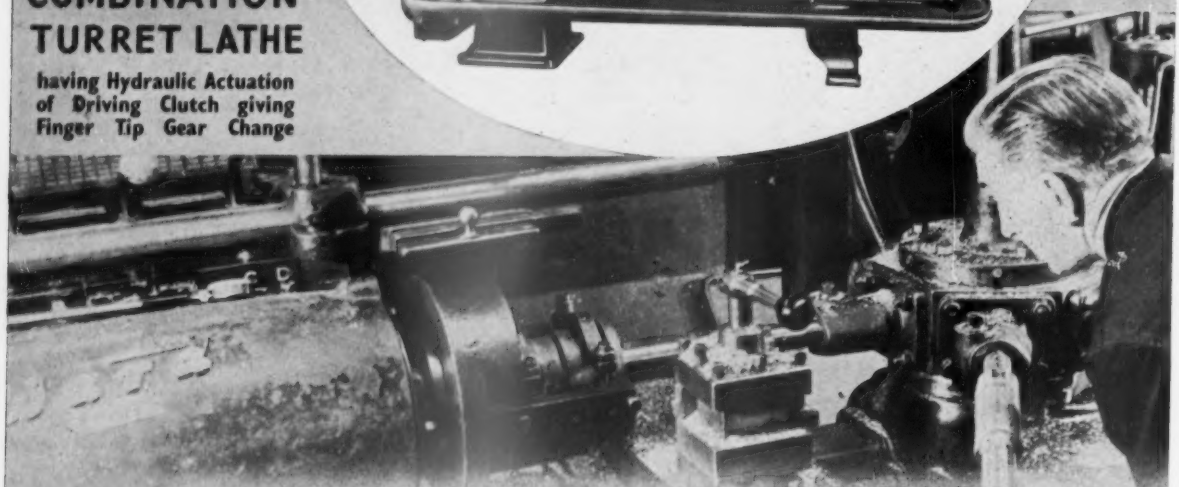
having Hydraulic Actuation of Driving Clutch giving Finger Tip Gear Change



Photographs by courtesy of The National Gas and Oil Engine Co. Ltd. Ashton-under-Lyne



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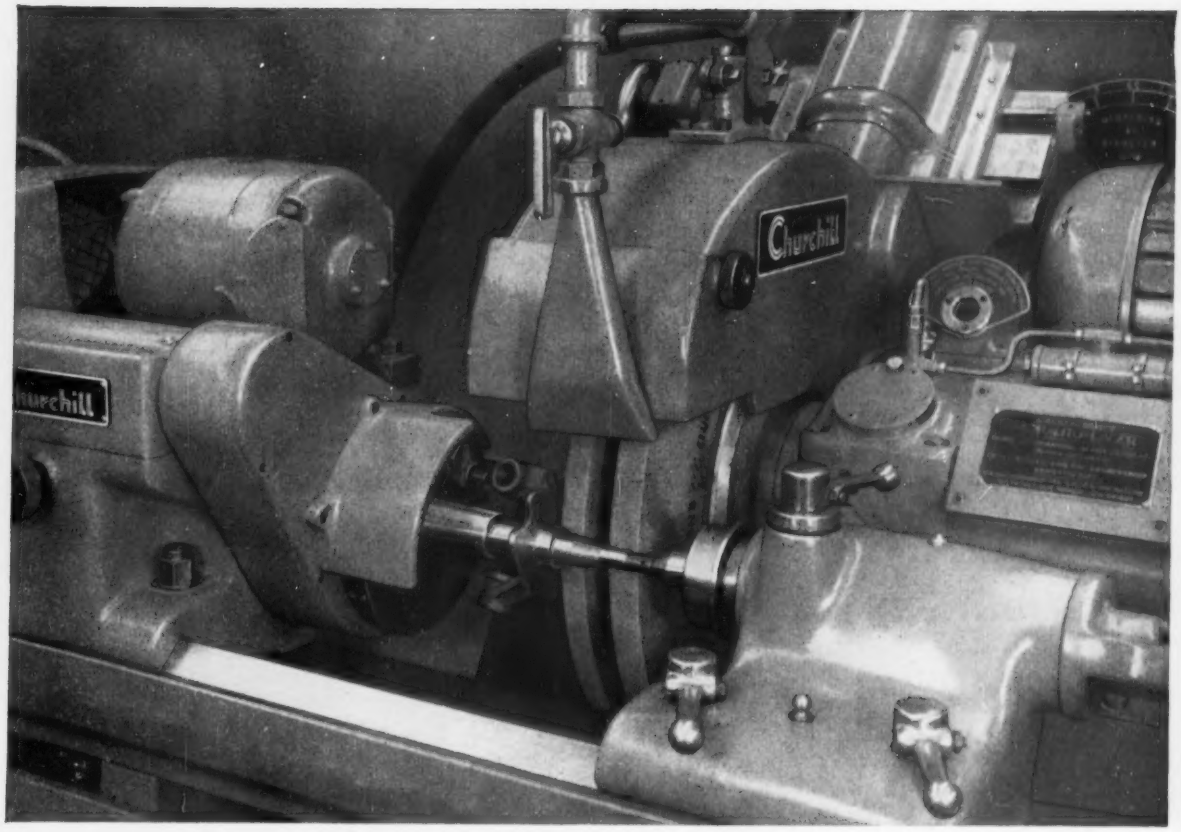
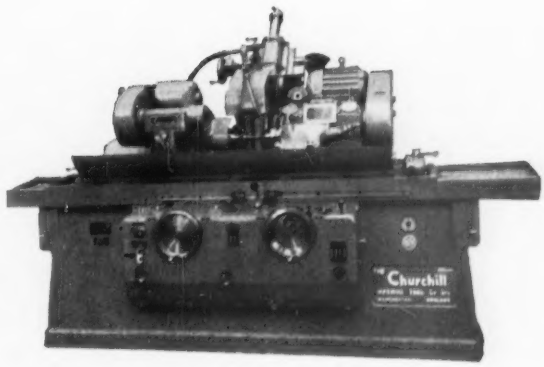


Churchill

THE CHURCHILL Model 'BW' 10" swing Plain Grinding Machine has a reputation for accuracy and high output. The machine shown here is equipped with twin grinding wheels for grinding two diameters simultaneously. The wheel forming device is mounted permanently on the back of the wheelhead and enables the wheels to be trued in correct relationship to the finished work diameters.

The 'BW' Machine can be supplied as a non-automatic or fully automatic Plain Grinder.



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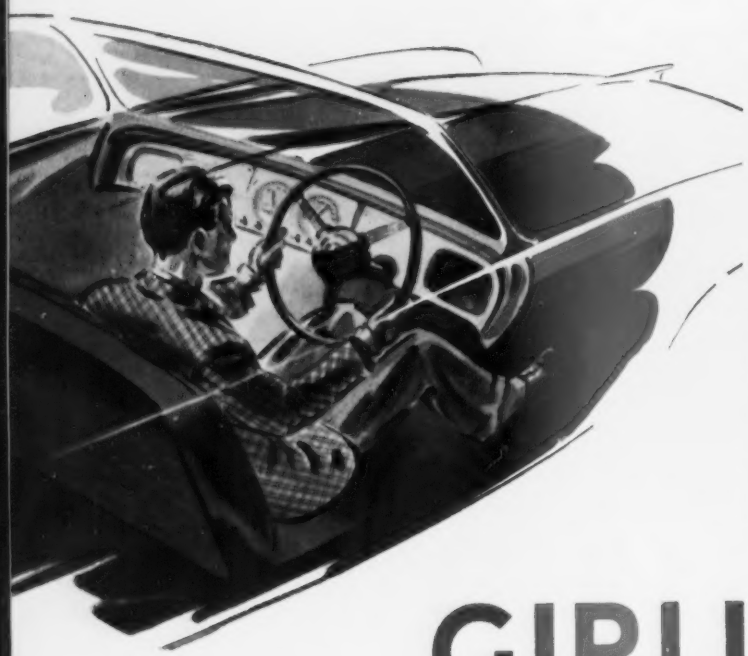
The advent of POWER ASSISTED STEERING



—another lead by GIRLING in the drive for safer motoring

As a direct contribution towards ease of handling and the elimination of fatigue when driving the heavier cars, as well as goods and passenger vehicles of all kinds, Girling Limited have developed a hydraulically operated device which gives power assistance to the effort derived from manual turning of the steering wheel.

Even on the heaviest vehicles the device gives a lightness yet sureness of steering "feel" that has to be experienced to be appreciated, and the design is such that the power assistance can never in any circumstances get out of hand. It must always remain instantly and completely subordinate to the dictates of the steering wheel and to the hand of the driver.

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'Castability'

Ley's 'Black Heart' malleable castings have a high resistance to impact, yet are practically free from limitations as to shape.

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Coupled with the easy machinability of Ley's 'Black Heart', these factors are a great manufacturing asset, moreover the finished part is better suited to its duties.

The illustrations show, actual size, the front hub of a popular car, made from Ley's 'Black Heart', completely machined.

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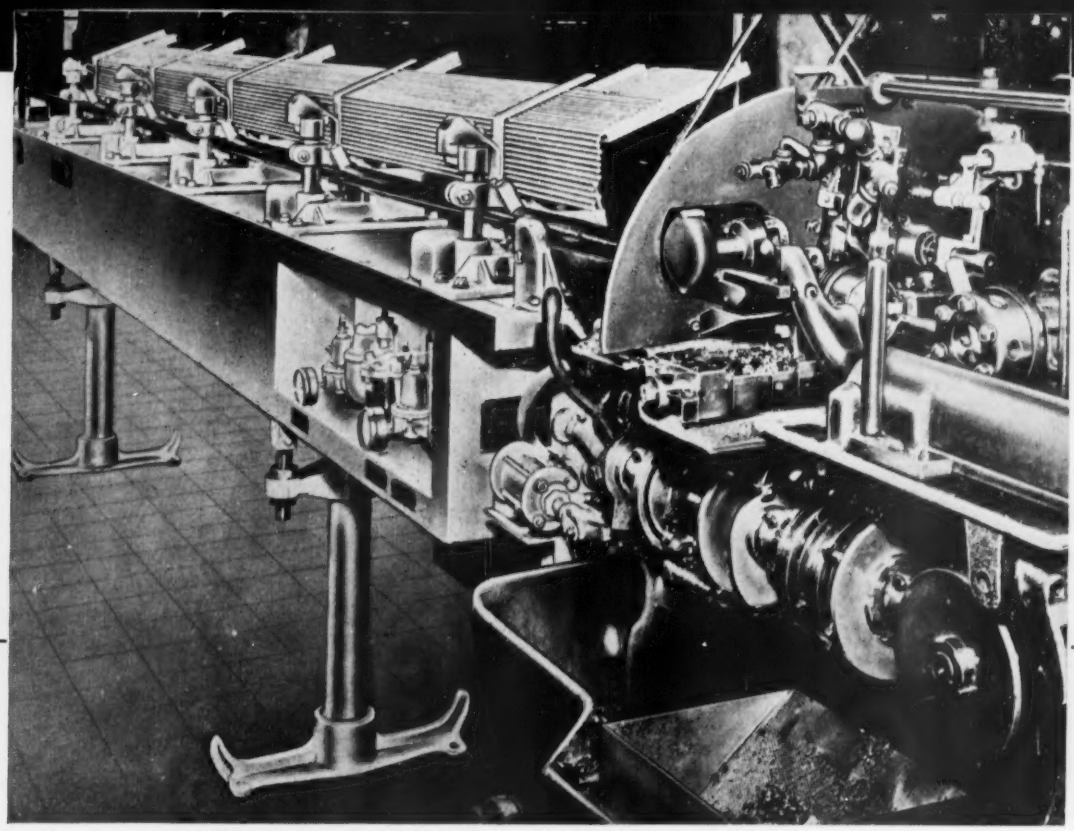
LEY'S

SCREW MACHINE FEED
that BREAKS THE TIME BARRIER!



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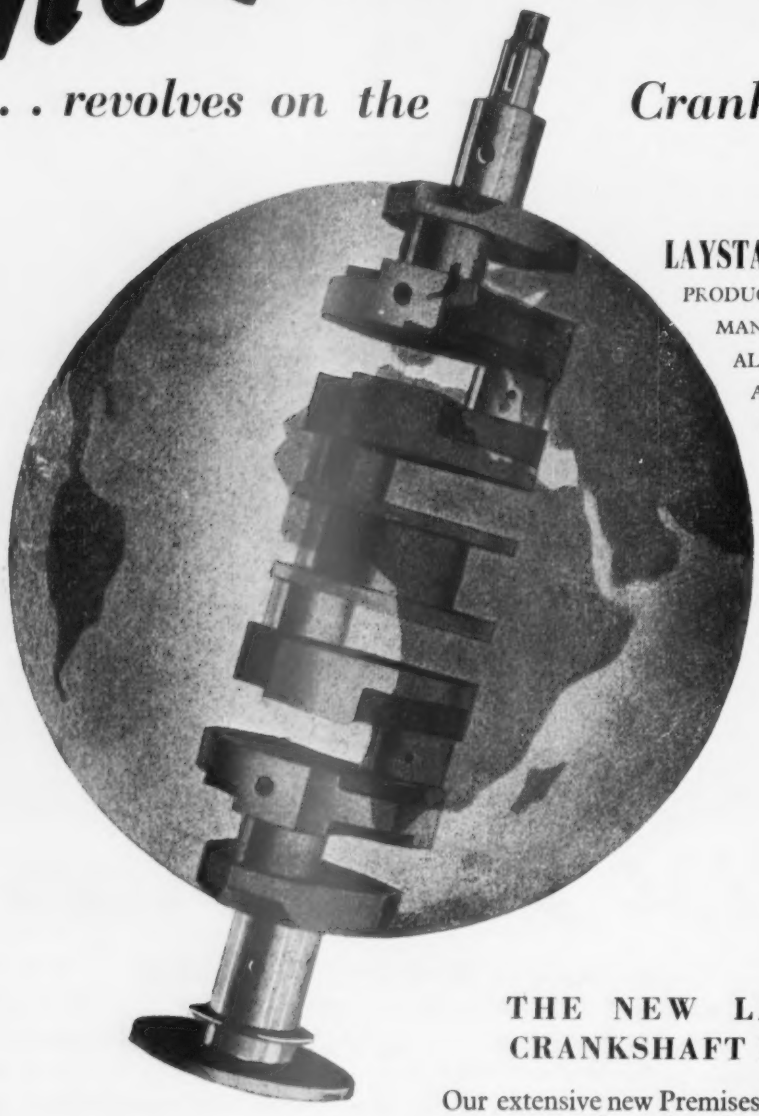

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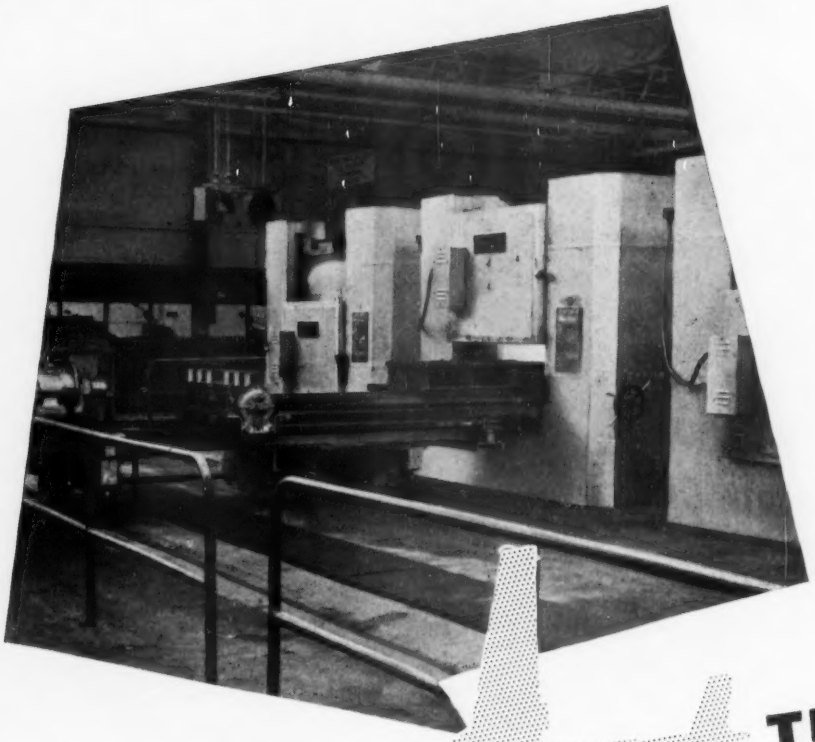

Considering the stresses involved there is perhaps no sphere where highly efficient heat treatment is more essential than in the production of engine components. G.W.B. electric furnaces have been installed at a number of factories for *precision* heat treatment. Shewn here is the installation at the Standard Motor Co. Ltd.

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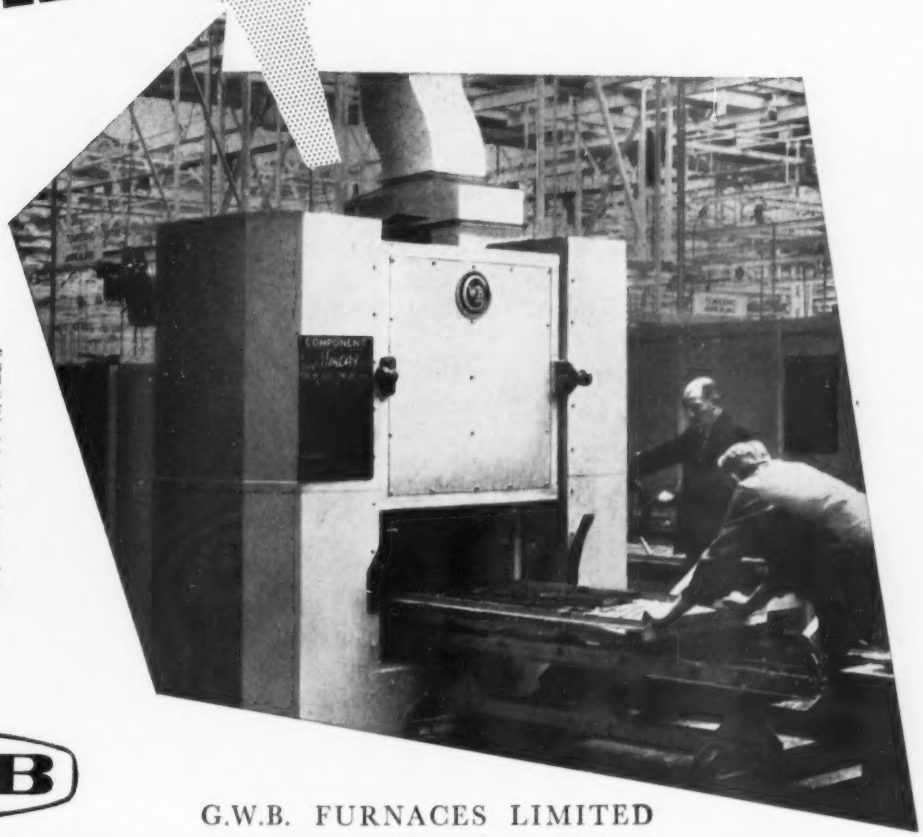

Photograph above shows battery of 3 'G.W.B.' furnaces served by an all electric traversing charging machine and used for pack carburising, normalising or annealing.

Photograph right shows small 'G.W.B.' tempering furnace fitted with air circulating fans and operating from 250°—650°C.

photos courtesy of STANDARD Motor Co. Ltd.

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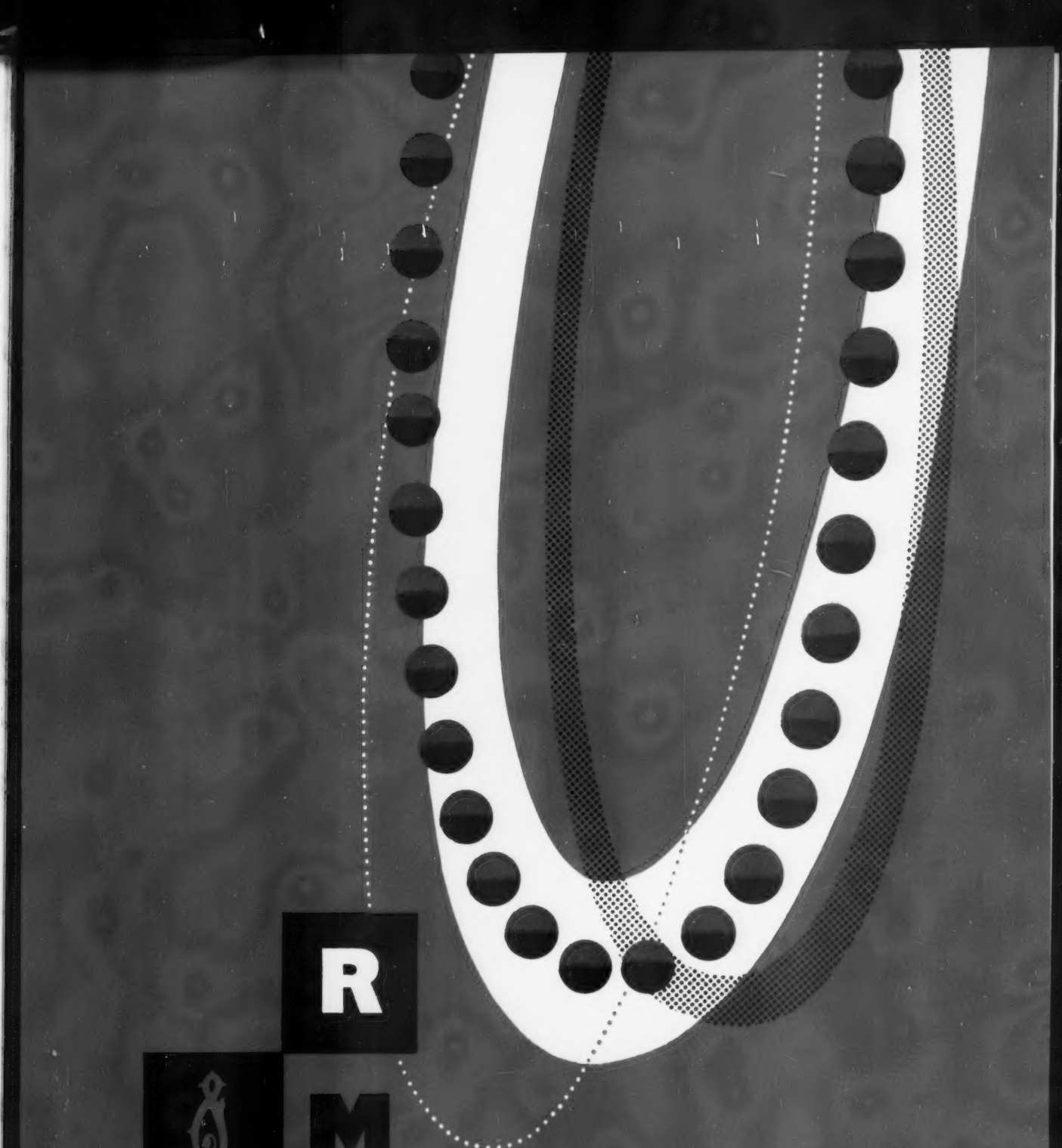

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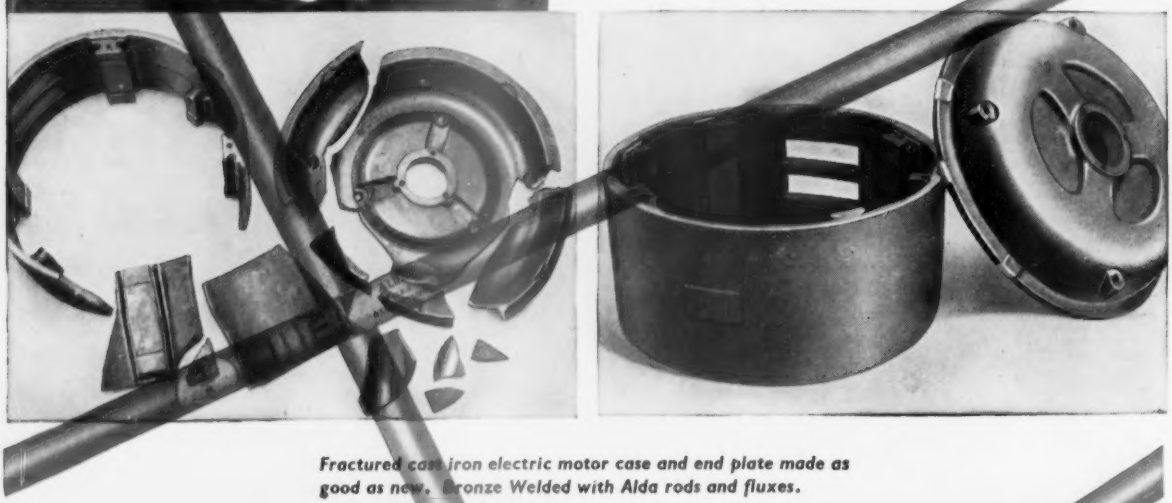
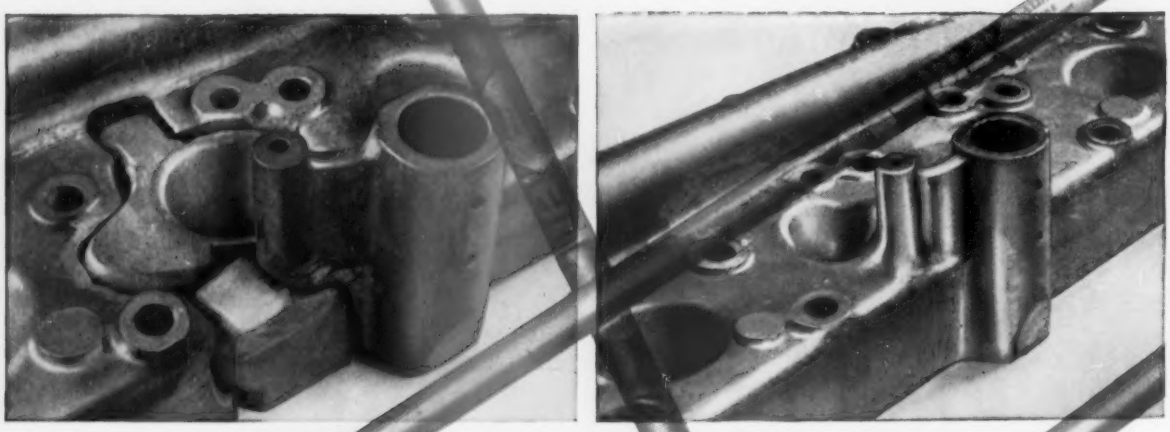


Fractured cast iron electric motor case and end plate made as good as new. Bronze Welded with Alda rods and fluxes.



A fractured aluminium cylinder head before and after repair with Alda rods and fluxes. At left, the casting is shown prepared for welding, and at right, the finished job — as good as new.

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This cast-iron binder attachment is being repaired by welding a lug on to the arm. The Blowpipe is the B.O.C high pressure type CH, the rod an Alda Cast Iron Super Silicon, and the flux Alda cast iron.

Gas welding is widely used for repair and reconditioning in the automobile industry — for aluminium and sheet steel bodies as well as aluminium and cast iron engine parts. Here, a shattered wing is being made good, using an Alda Mild Steel Copper coated welding rod.

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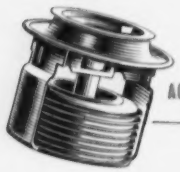

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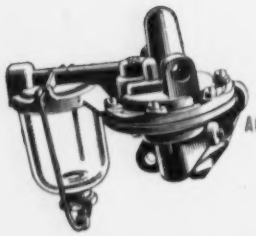

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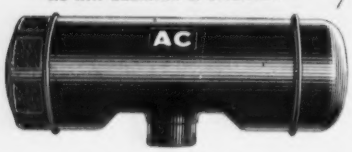

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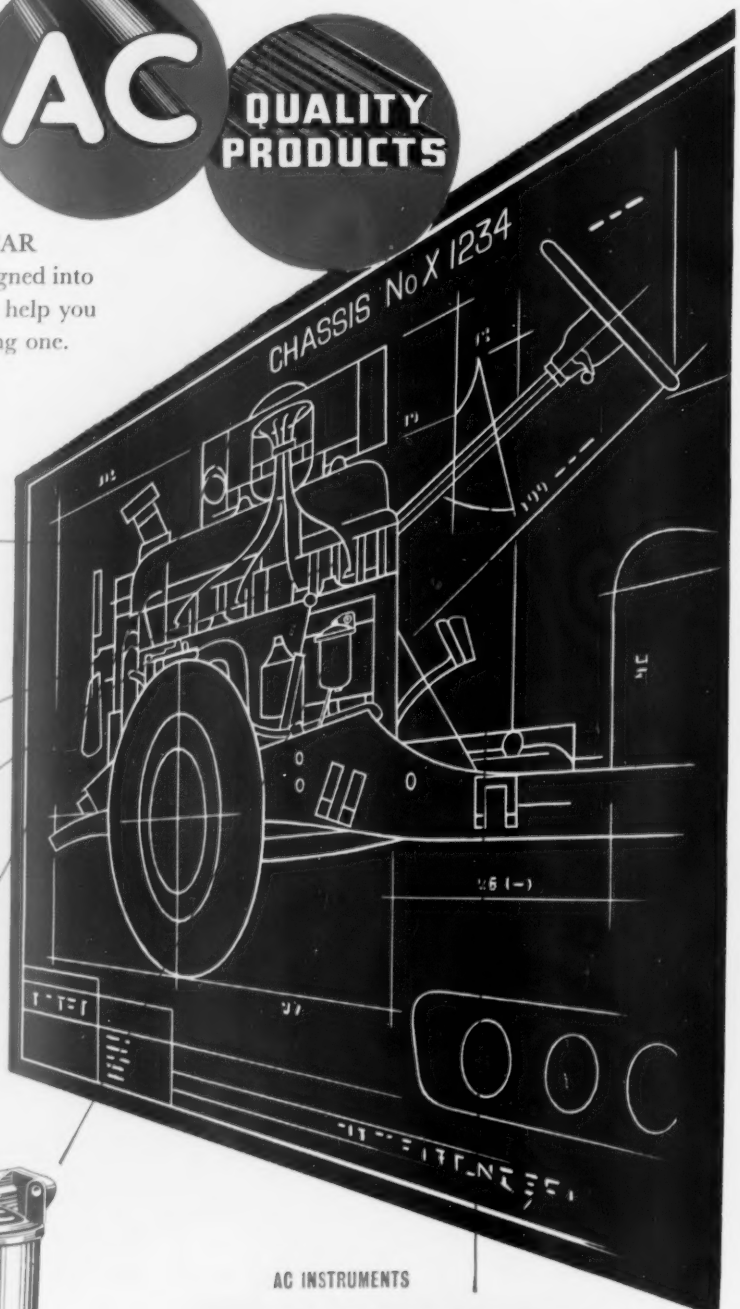

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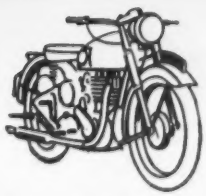

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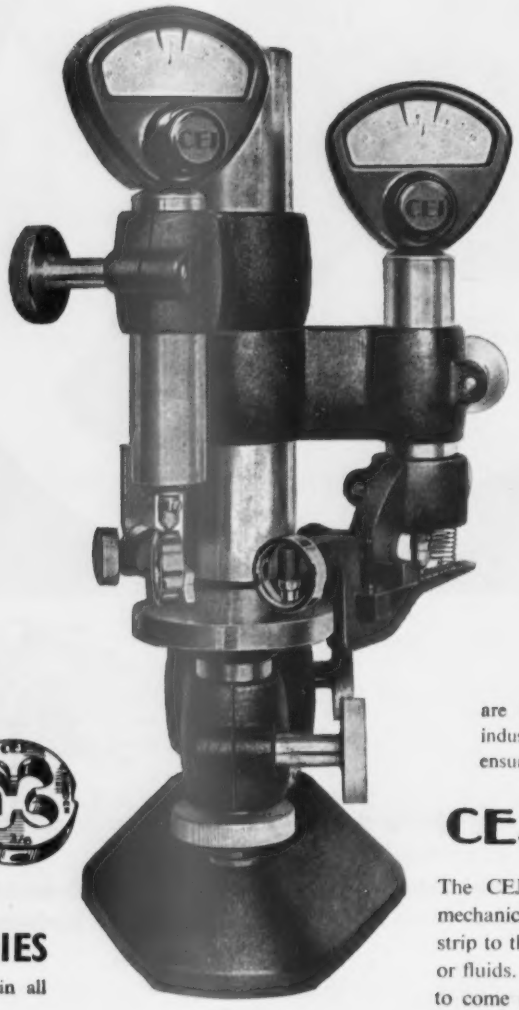

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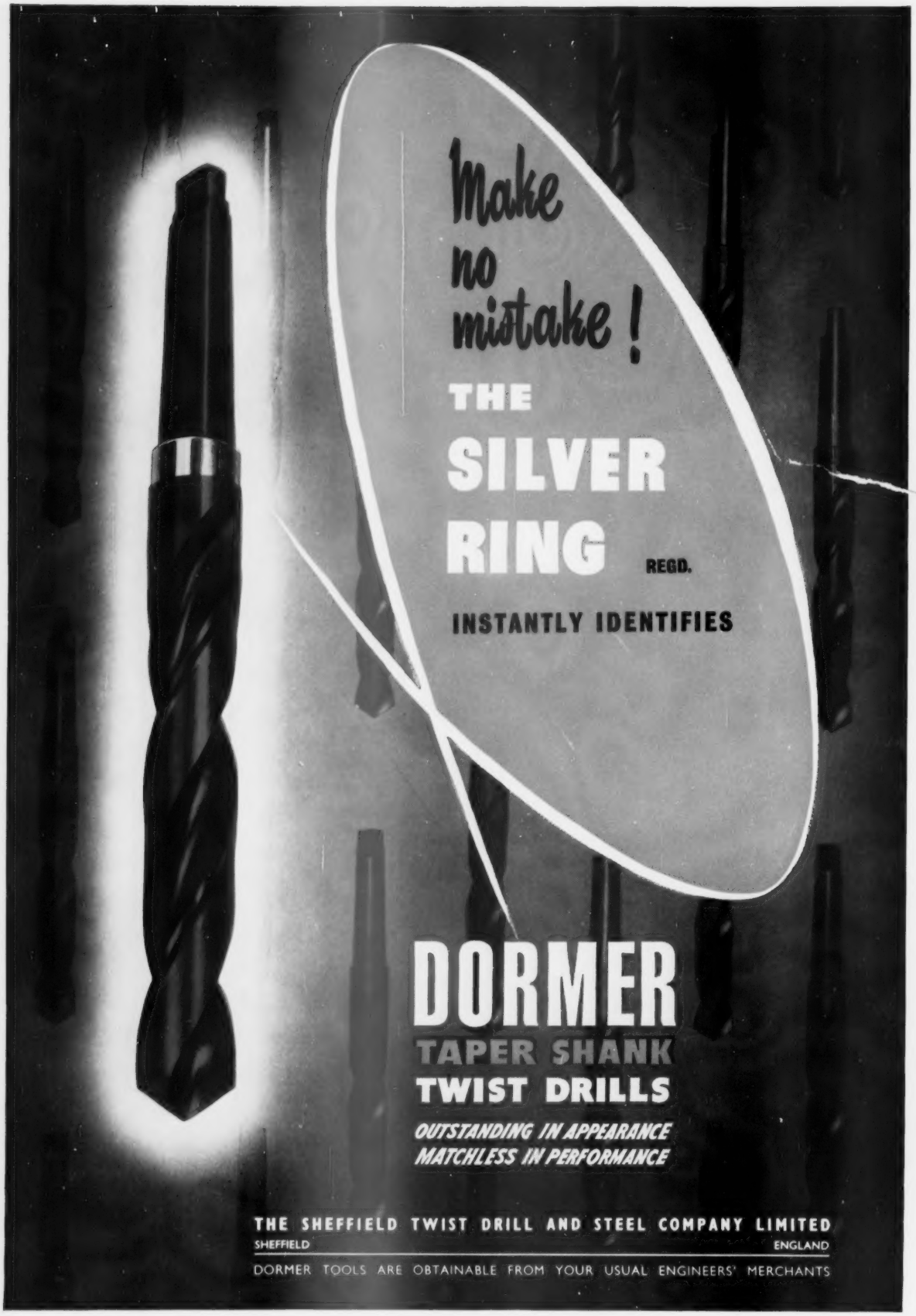
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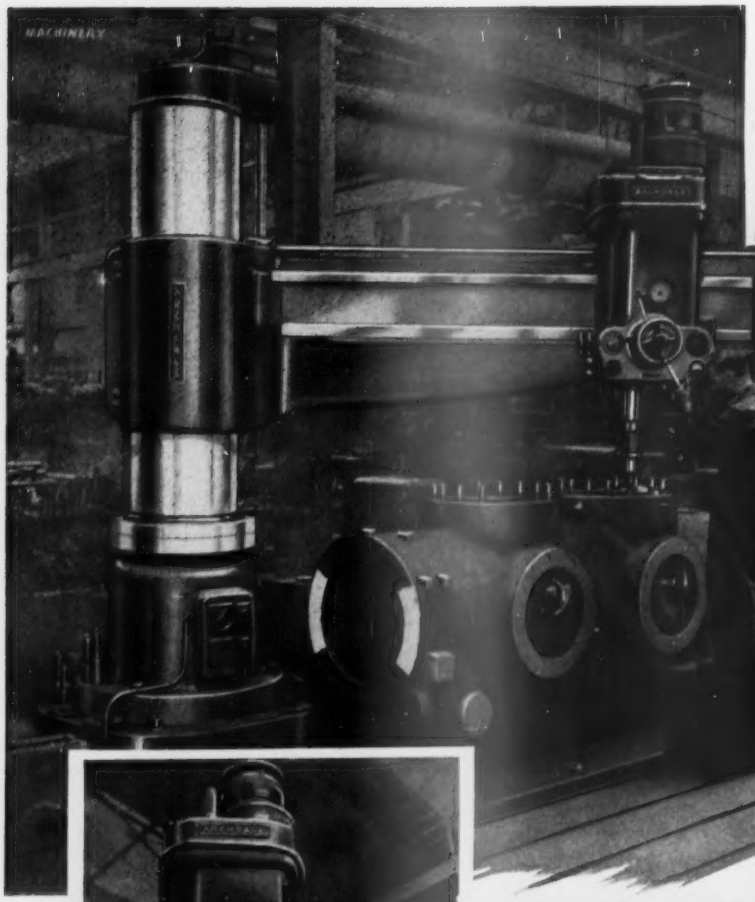

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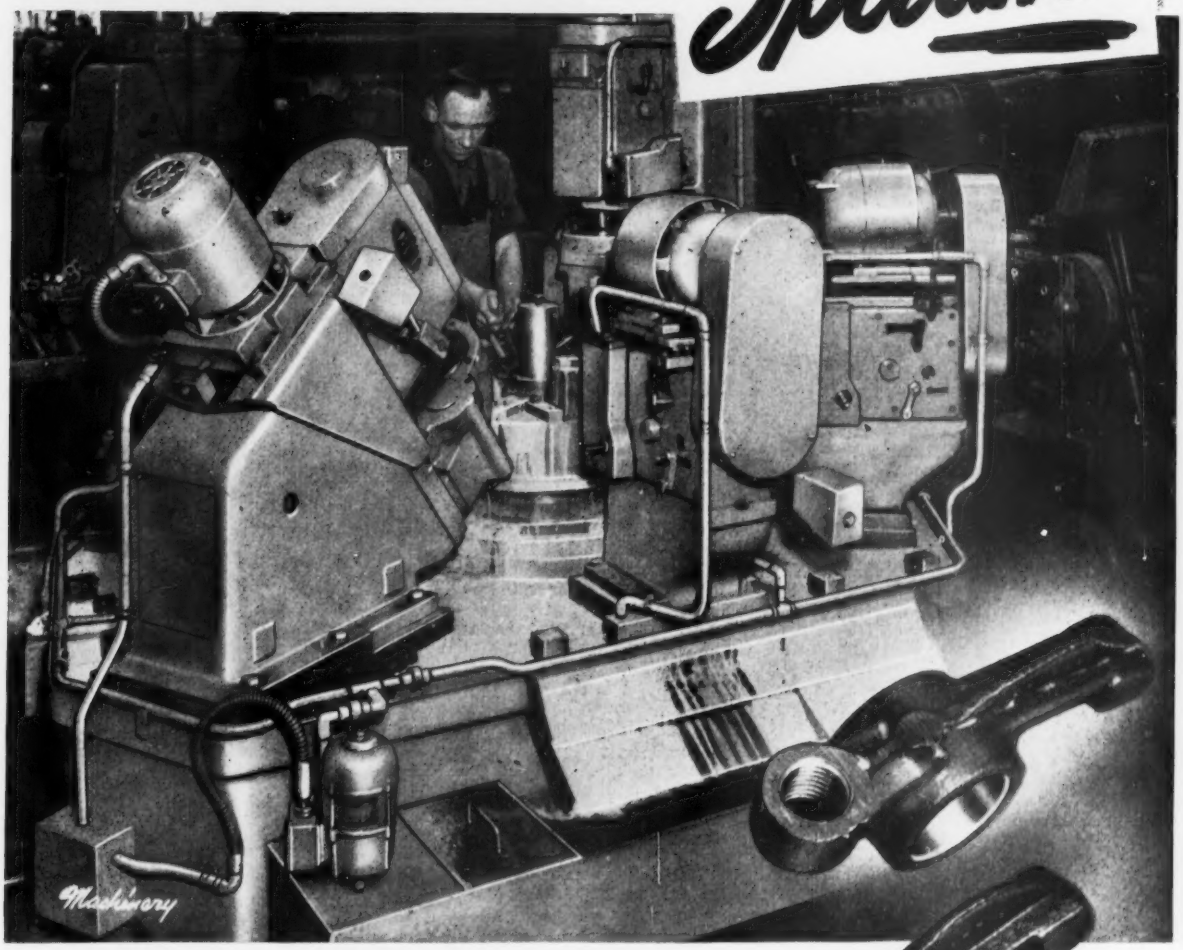

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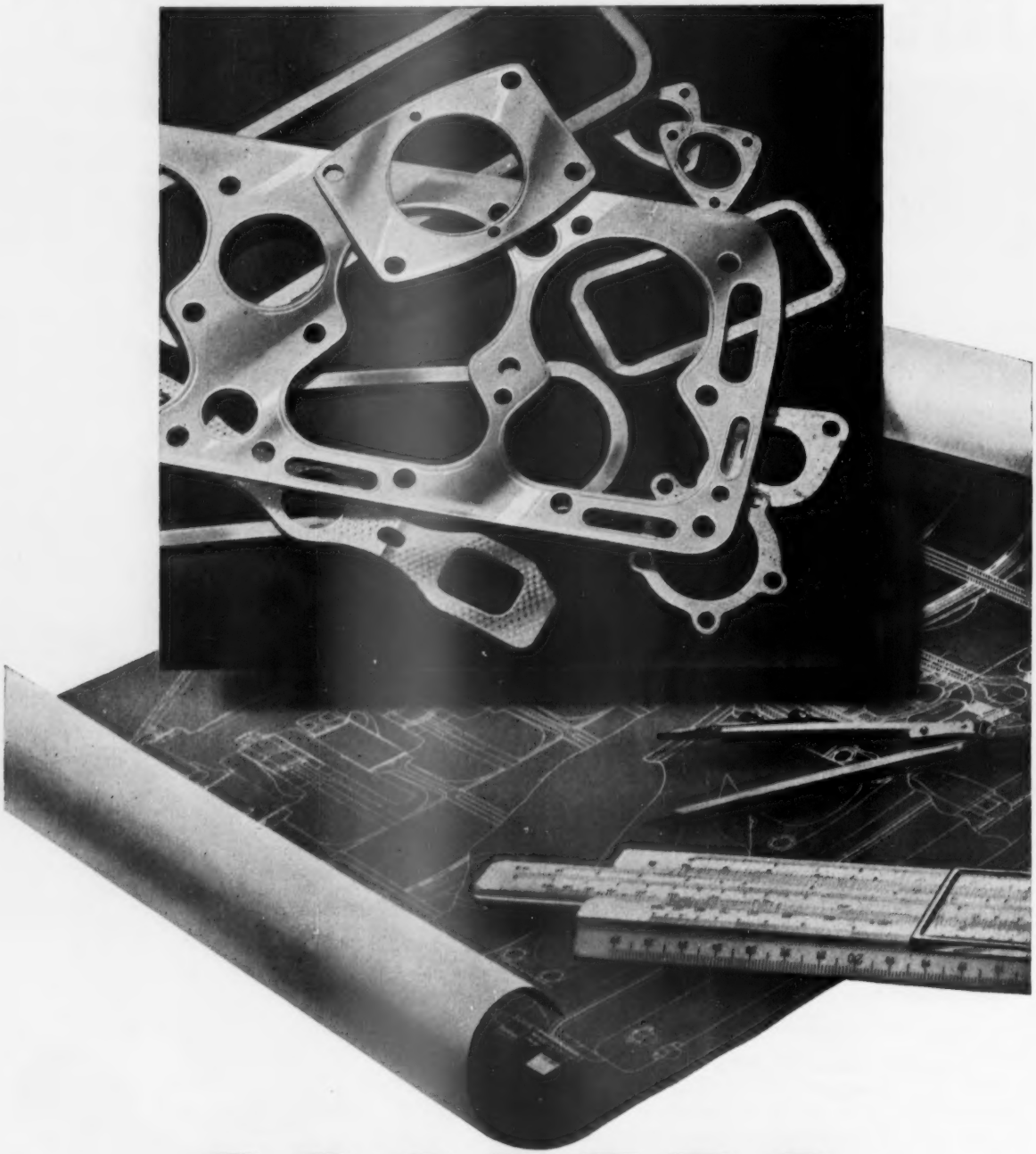

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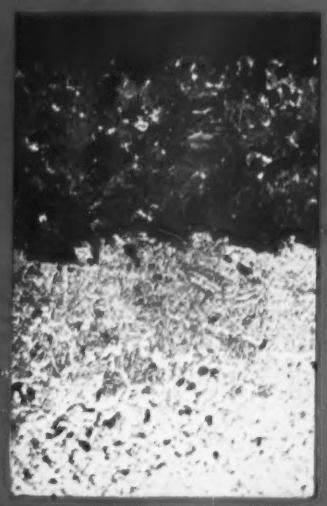

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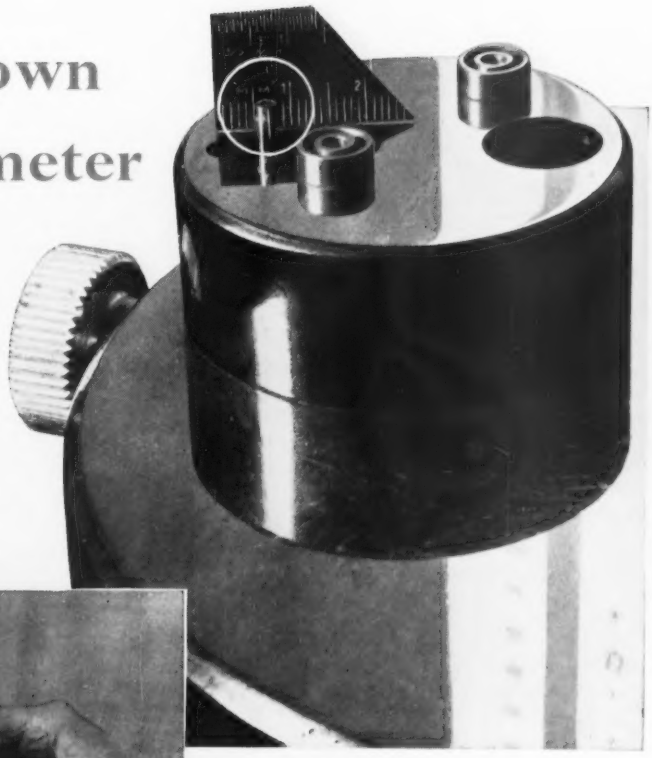

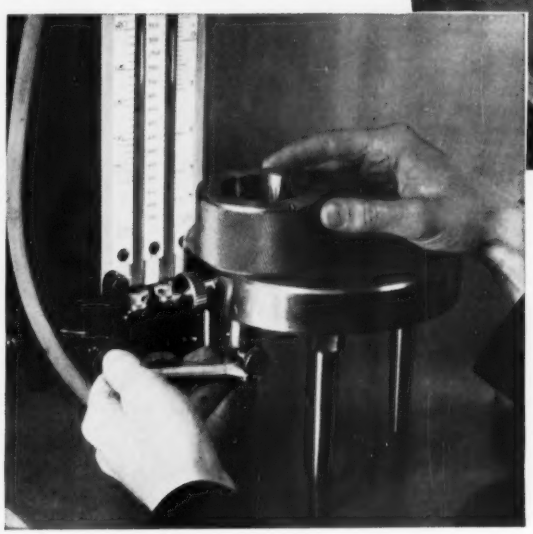

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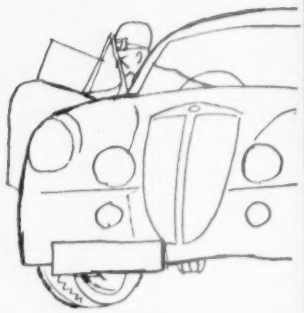

TESTING takes place throughout the production of Ferodo Anti-FadeBrake Linings, from investigation of basic materials to inspection of finished products. The laboratory, the uniquely equipped Test House, the powerful cars of the Ferodo Test Fleet, all are constantly at work, making the efficiency and safety of Ferodo Linings a calculated certainty.

FERODO FACILITIES FOR RESEARCH AND TESTING ARE FREELY AVAILABLE TO THE MOTOR INDUSTRY AT ALL TIMES

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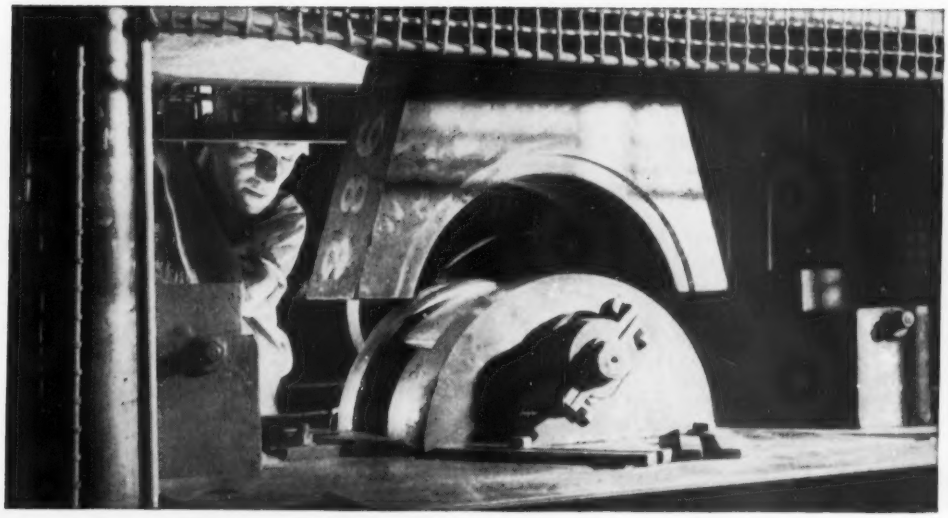

In the MANUFACTURE of Ferodo Linings, the emphasis is on precision. Whether it's a hydraulic press forming liners to their finished radius, or a giant multiple drill, every machine is itself the result of research and experience. This fact, combined with strict examination at every production stage, ensures that on any make of car in the world, the correct Ferodo Lining will always fit perfectly.

FERODO

ANTI-FADE Brake Linings

Clutch Facings

'ERODO LIMITED • CHAPEL-EN-LE-FRITH *A Member of the Turner & Newall Organisation*

TOOLROOM FAVOURITES

Illustration by courtesy of Siemens Brothers & Co. Ltd.

KE 970 This type of 2% Carbon 14% Chrome Steel is recommended for the highest duty work possessing the desired properties of deep hardening, a high resistance to abrasion together with the minimum amount of distortion in hardening. It also has the ability to withstand drawing in tempering after hardening over a much wider range of temperature than is normally permissible with standard alloy tool steel types. We also supply K. E. 961 1½% Carbon 14% Chrome Steel in cases where increased toughness is desired at the expense of a slight reduction in hardness.

KE 595 A finely made type of Oil-Hardening Alloy Tool Steel, hard, durable and of excellent torsional properties in the hardened and tempered state and possessing low distortion values. Eminently suitable for Cut-Thread Taps, Reamers, Gauges, End Mills, Broaches, Press Tools etc.

KE 672 The original universally known "Blue Line Die Steel". An excellent oil-hardening low distortion General Tool room quality.

KE 637 A low temperature oil-hardening, non-shrinking quality possessing all those desirable features of a first grade tool steel.

All K.E. Tool Steels are supplied in the annealed condition, carefully controlled both with regard to temperature and atmosphere to render them most suitable for subsequent tool room manipulation.

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CARLISLE STEEL WORKS · SHEFFIELD · ESTABLISHED 1825

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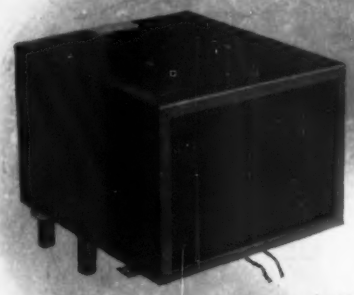
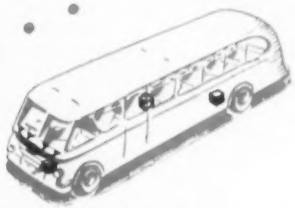
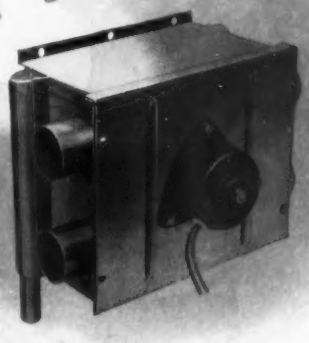
New units that need no ducting!

FOR FORWARD FITTING OR UNDERSEAT HEATER



and screen demisting . . . .





highly efficient

The 'S.12' heater with its high heat output is the ideal heating unit for any type of passenger vehicle. It can be used singly or for the larger coaches two or three units may be evenly disposed in the saloon, depending of course on the size and design of the vehicle and operating conditions required.

The 'S.8' demister unit has four separate high velocity outlets, and is the simplest method of preventing mist and ice formation on the driver's screens and windows.

light and compact

Completely self-contained and fully enclosed, both units are compact and of lightweight construction. Easy access is provided for cleaning the element and servicing the motor.

easily installed

The 'S.12' heater is secured by four screws to the vehicle floor, the water connections being under floor. It may be situated at the front of the gangway or in under-seat positions. No ducting is required.

The 'S.8' demister is normally mounted in the panelling beneath the windscreen and centrally disposed to give a simple piping arrangement to the demister nozzles. Water connections are brought up from the under-floor piping layout.

Heating, plus efficient demisting equipment for the screens is an absolute necessity for the modern coach. The latest Clayton Dewandre units have been designed to meet the requirements for warming the saloon with the most efficient heat distribution, to provide an even temperature throughout the coach.

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Units are supplied with all fittings and connections for a complete vehicle installation. Motors are available for 6 –, 12 – and 24 – volt electrical systems.

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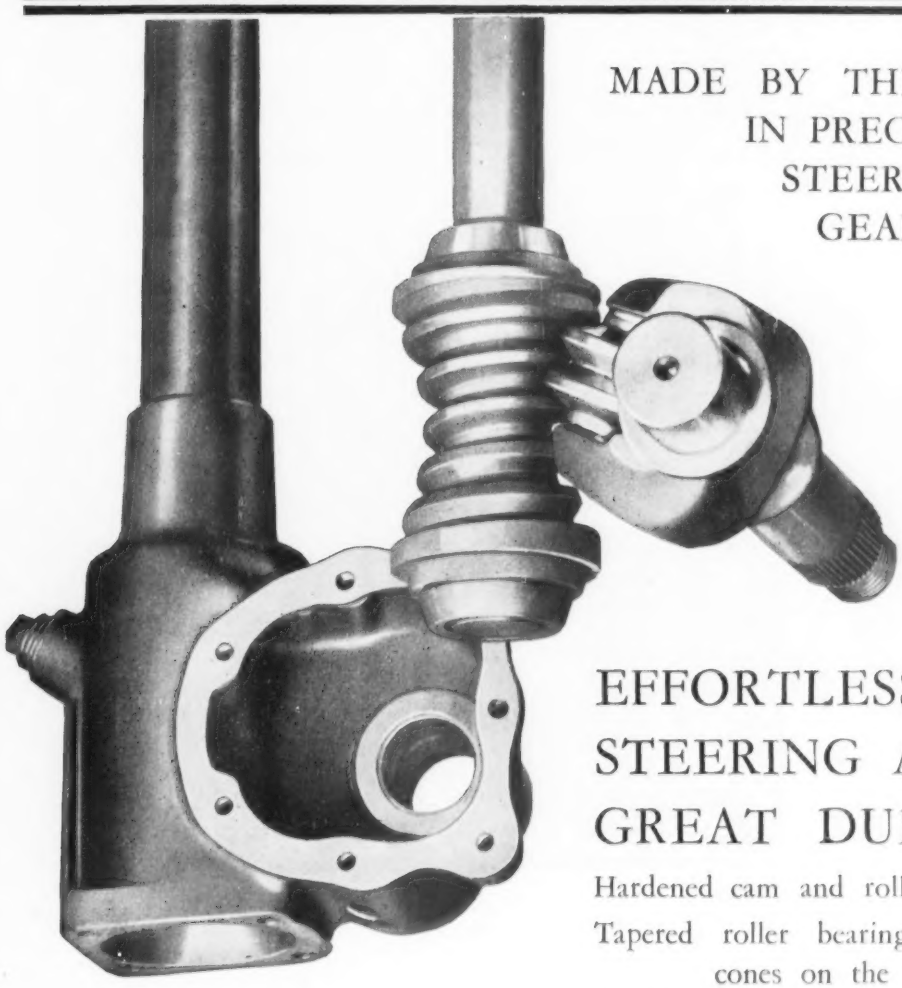

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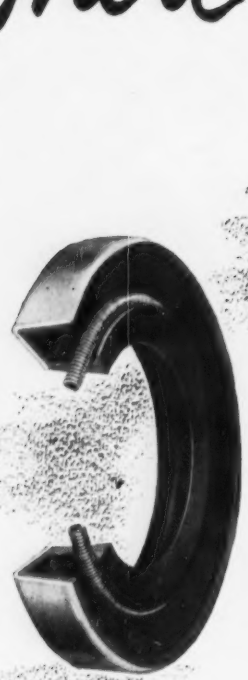

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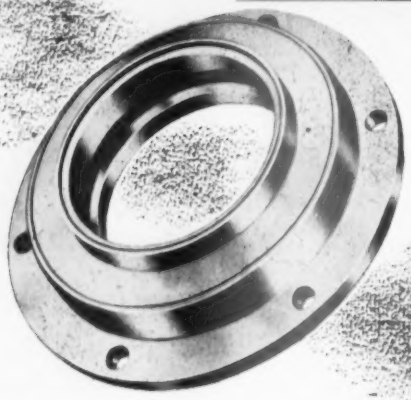

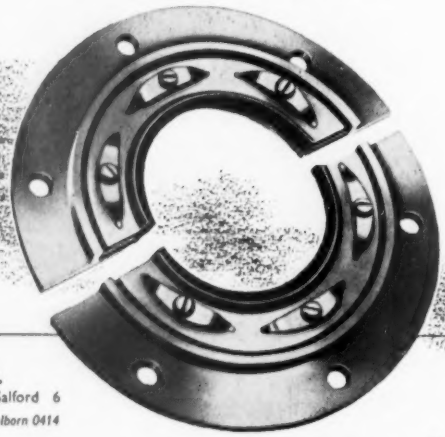

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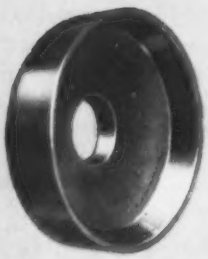

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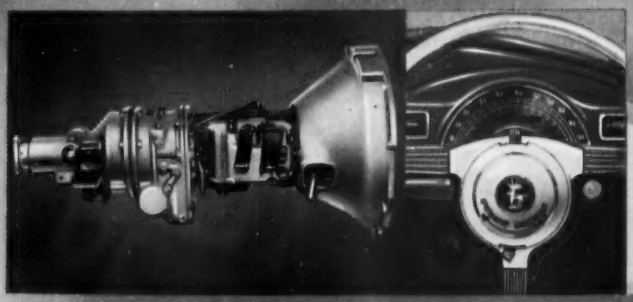
On these models second and top gears are overdriven giving five forward speeds. The Overdrive second makes an ideal overtaking and hill climbing gear. Control is by finger-tip electrical switch mounted under the steering wheel.



- FINGER-TIP DRIVER CONTROL UNDER ALL CIRCUMSTANCES
- NO MOVEMENT OF FOOT CONTROLS WHEN OPERATING OVERDRIVE
- ENGINE BRAKING IN ALL GEARS

SUNBEAM ALPINE

This high performance luxury sports car has Overdrive on top gear, controlled by an electrical switch on the steering column. At a 100 m.p.h. in Overdrive top the engine r.p.m. is only 4245.

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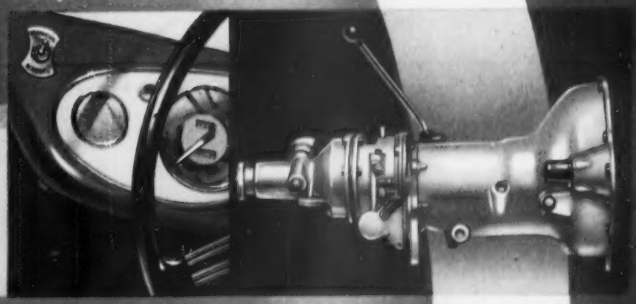
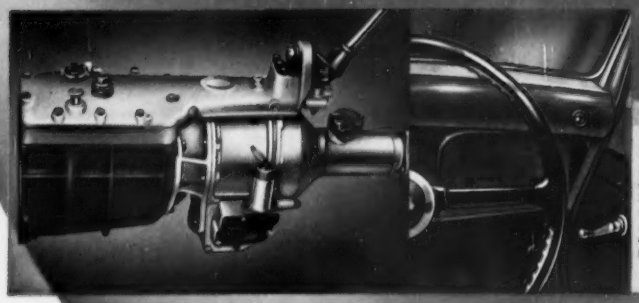


AUSTIN HEALEY 100

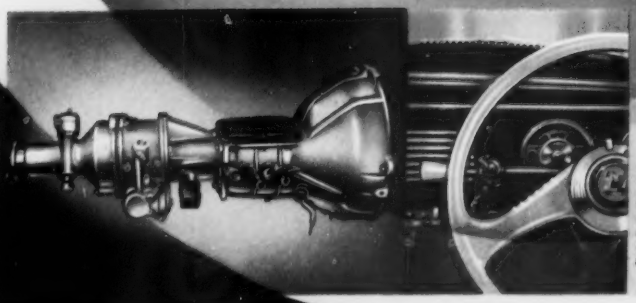
Overdrive on second and top gears by automatic engagement. An electrical switch on the fascia gives the driver over-riding control. At 100 m.p.h. the r.p.m. in Overdrive top is 4345.



JAGUAR MARK VII

On this car of "Grace, Space and Pace" the Overdrive operates on top gear only by automatic engagement. The driver can at any time override the Overdrive by means of an electrical switch on the fascia.

- PETROL SAVING OF UP TO 20% IN OVERDRIVE



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Here the driver has the choice of either Manual or Automatic operation of Overdrive by means of an electrical switch mounted on the gear change lever. Both second and top gears are Overdriven.

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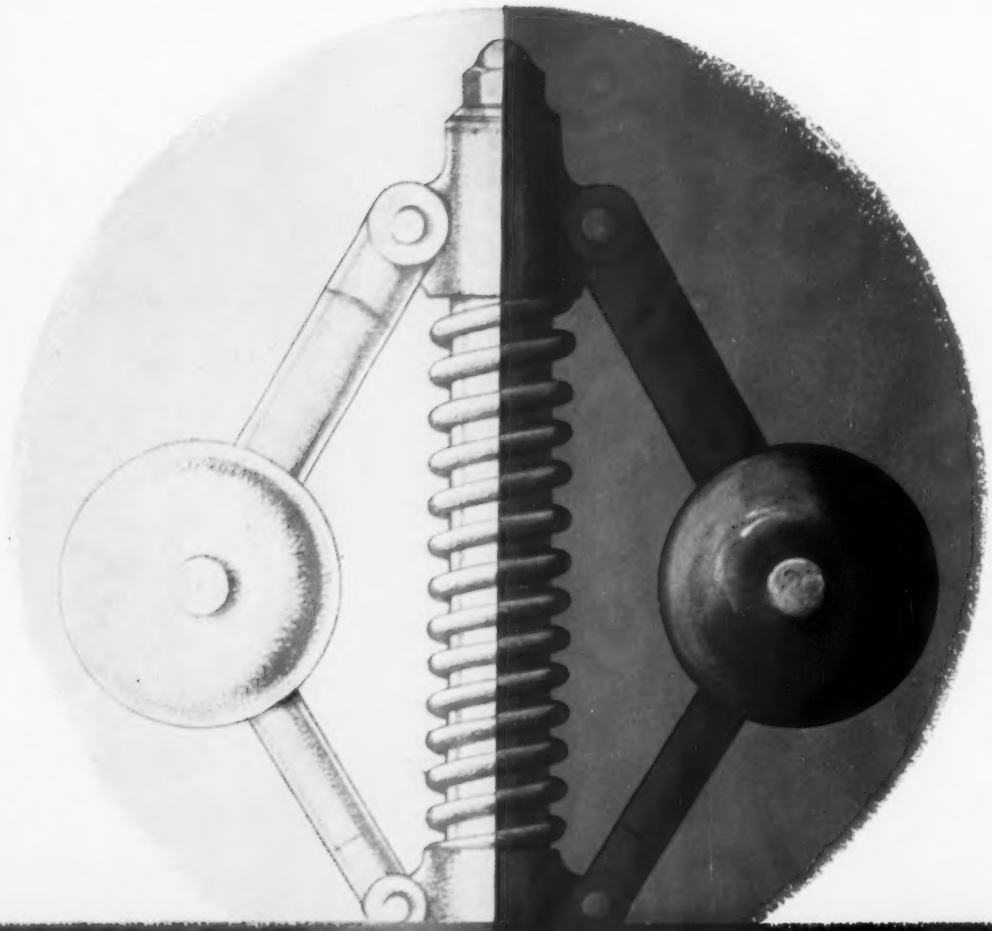

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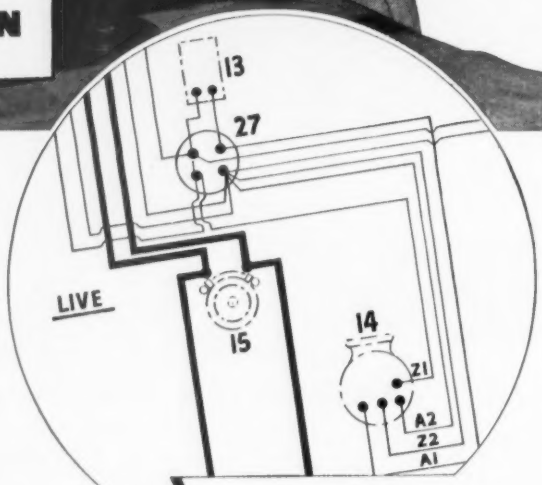

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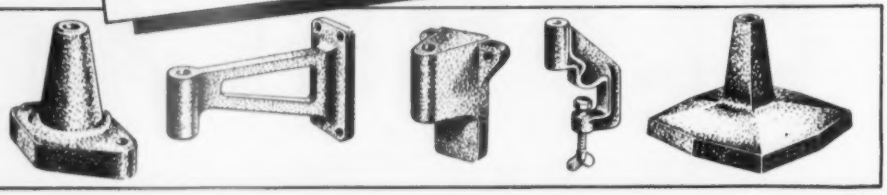

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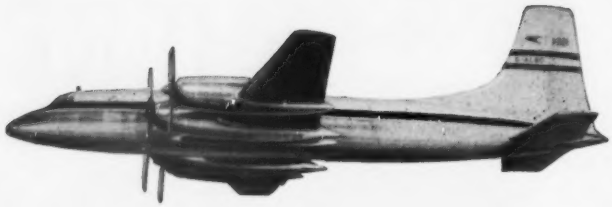

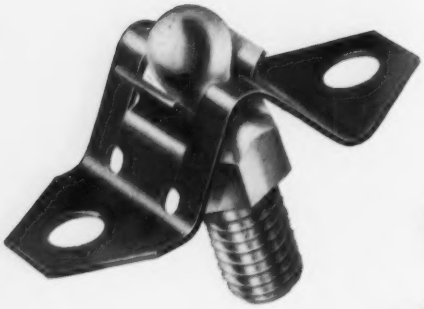

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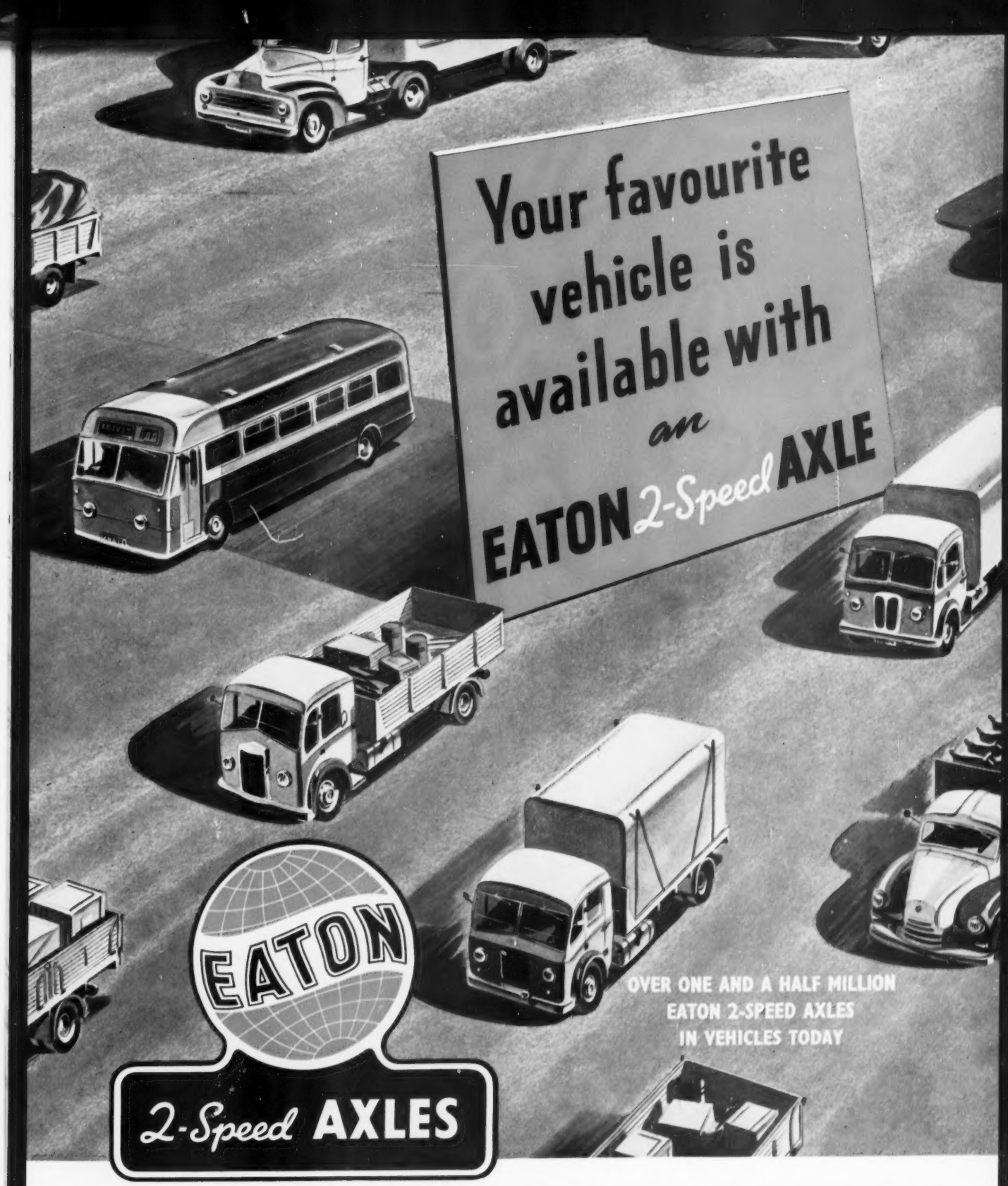
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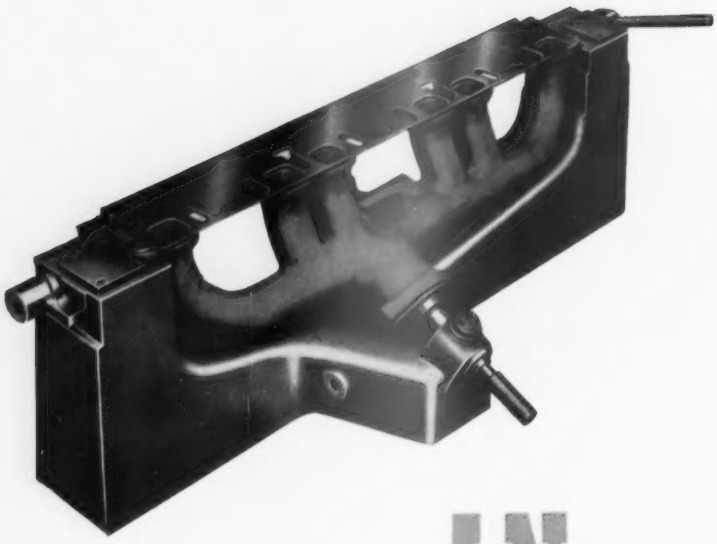

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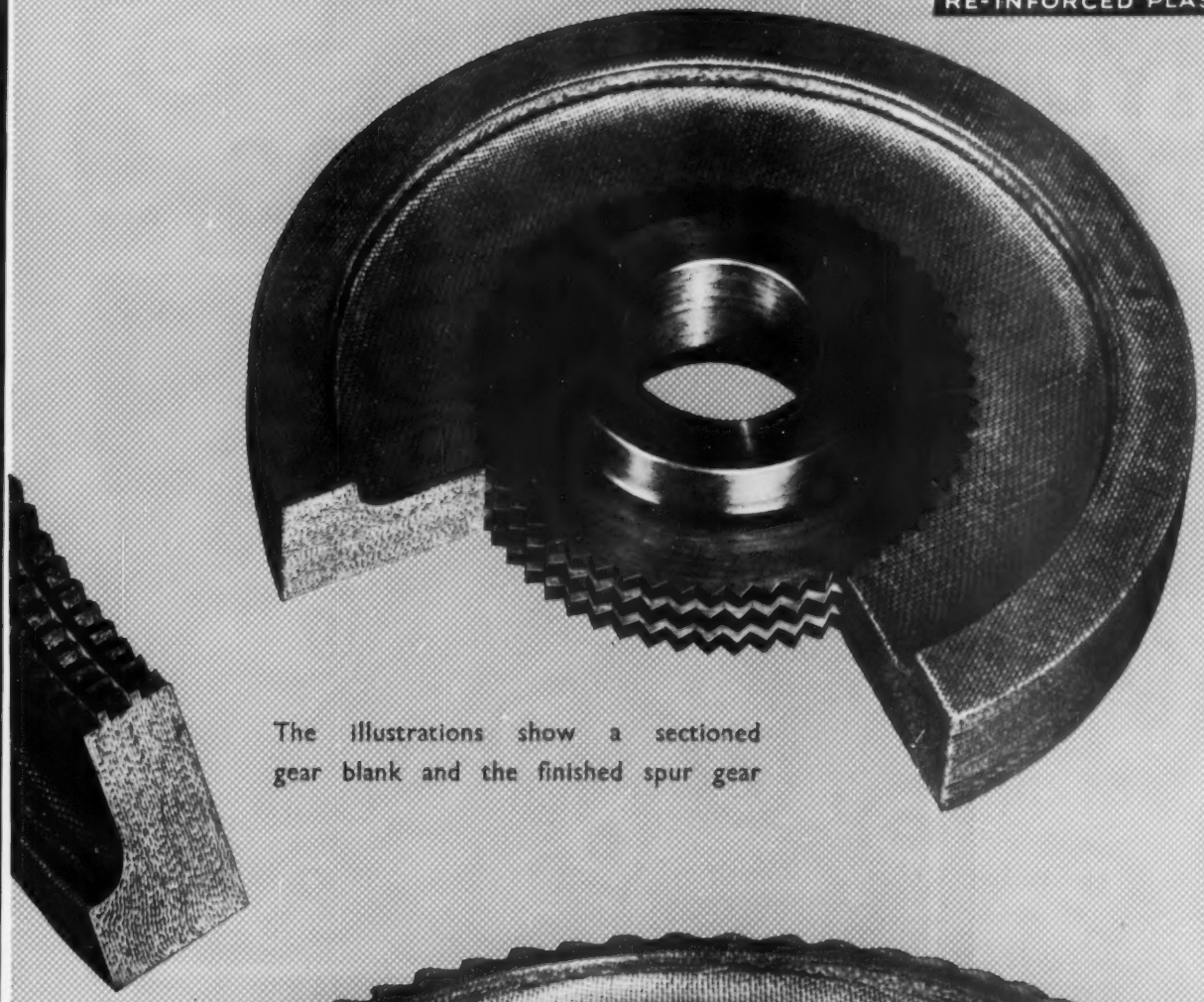
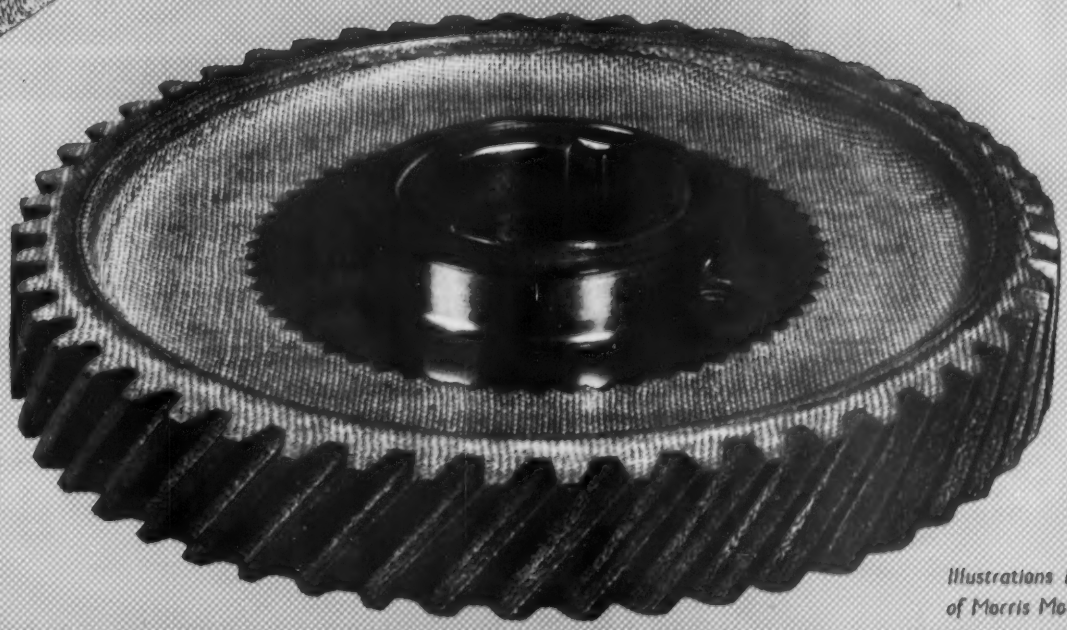


The illustrations show a sectioned gear blank and the finished spur gear



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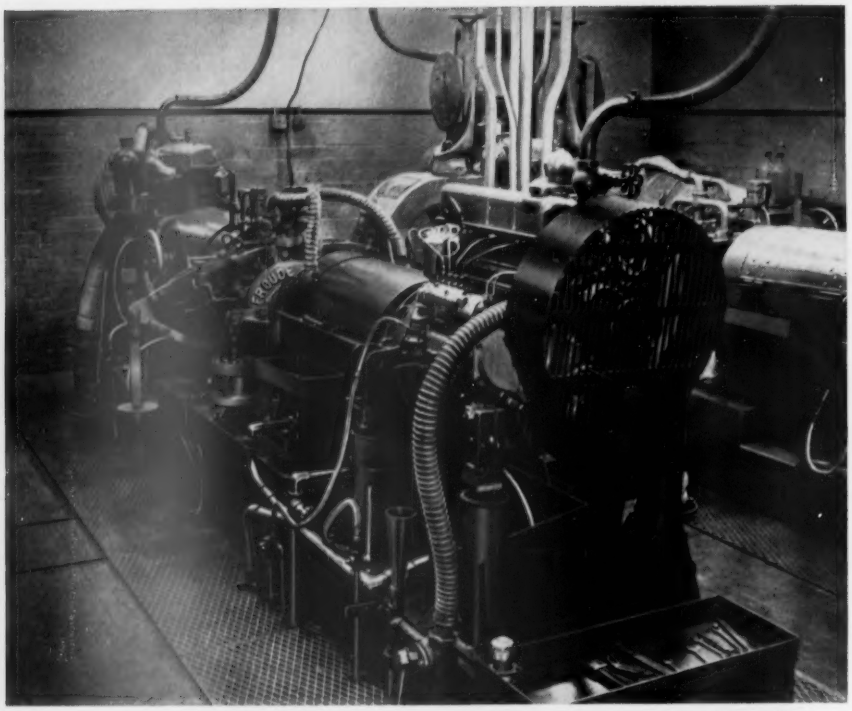

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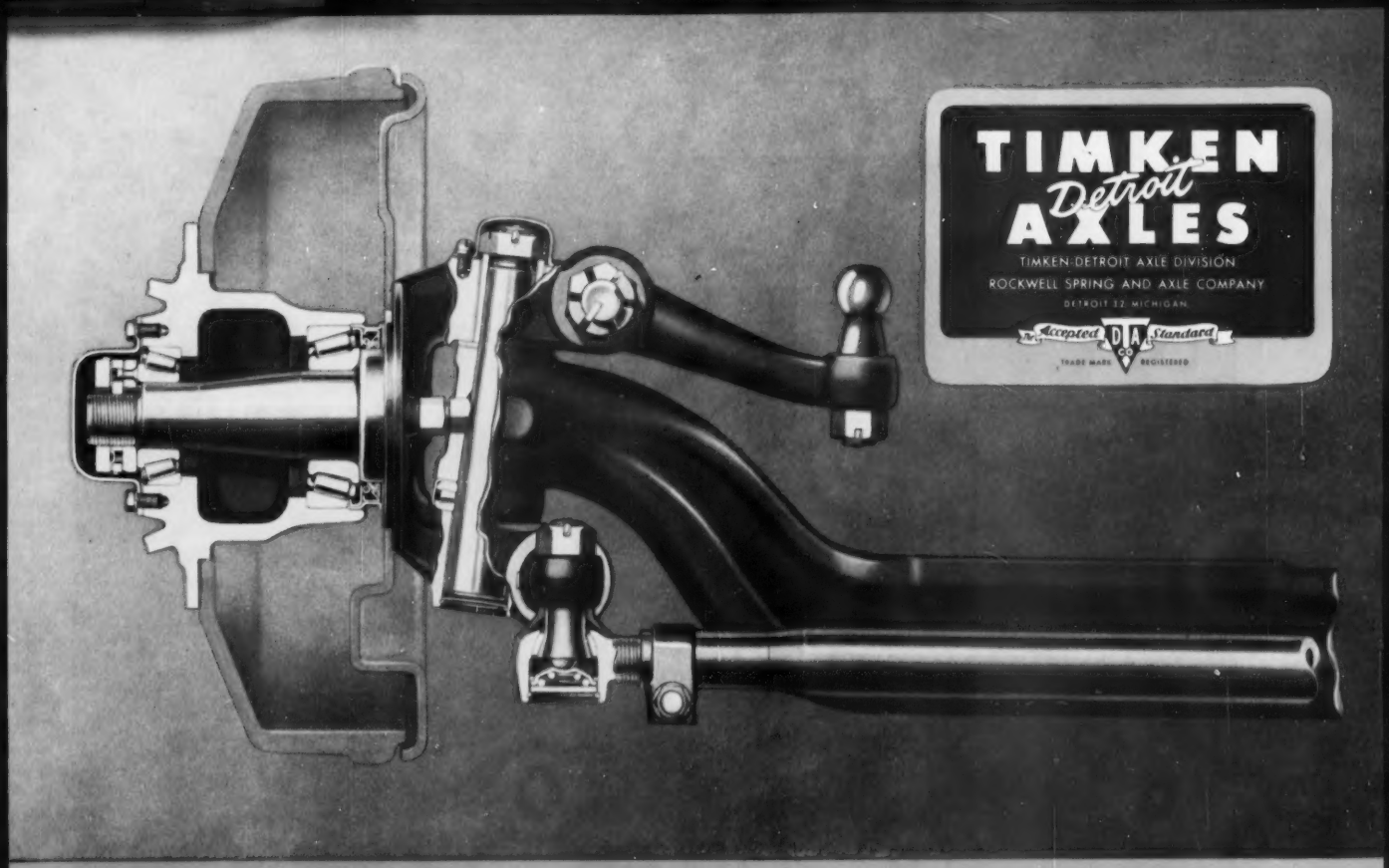

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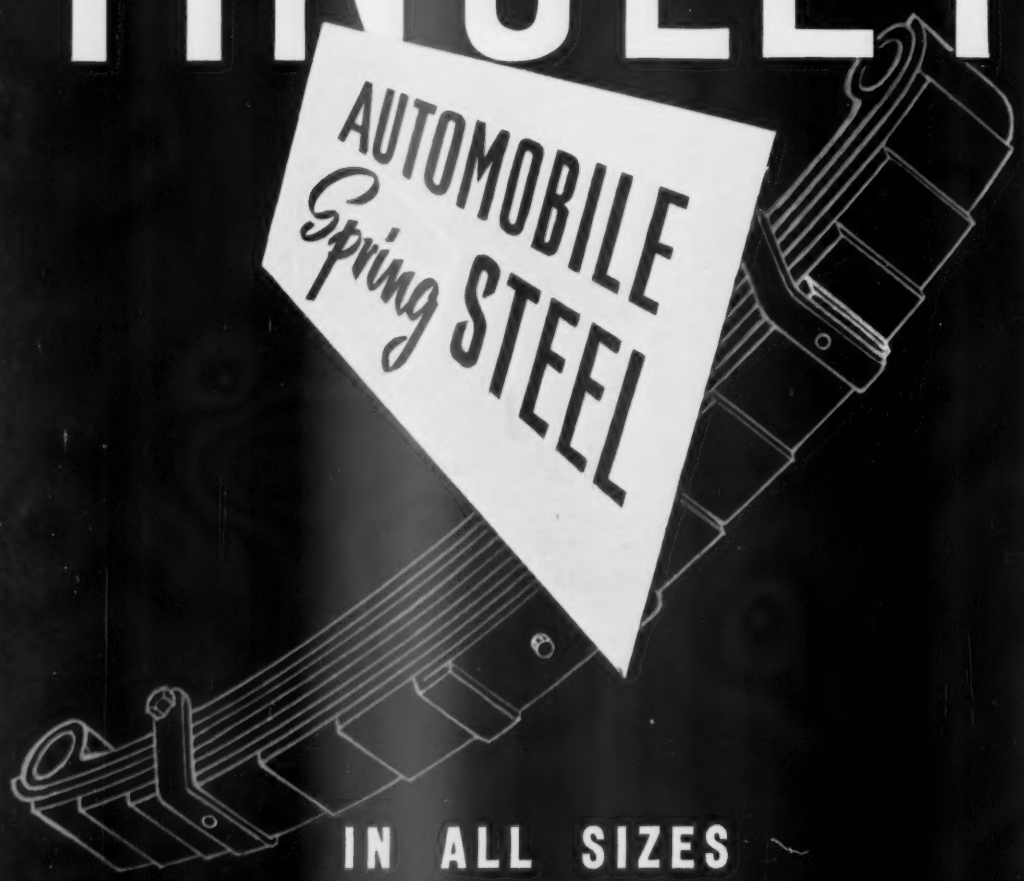

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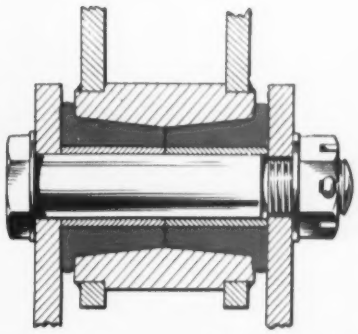

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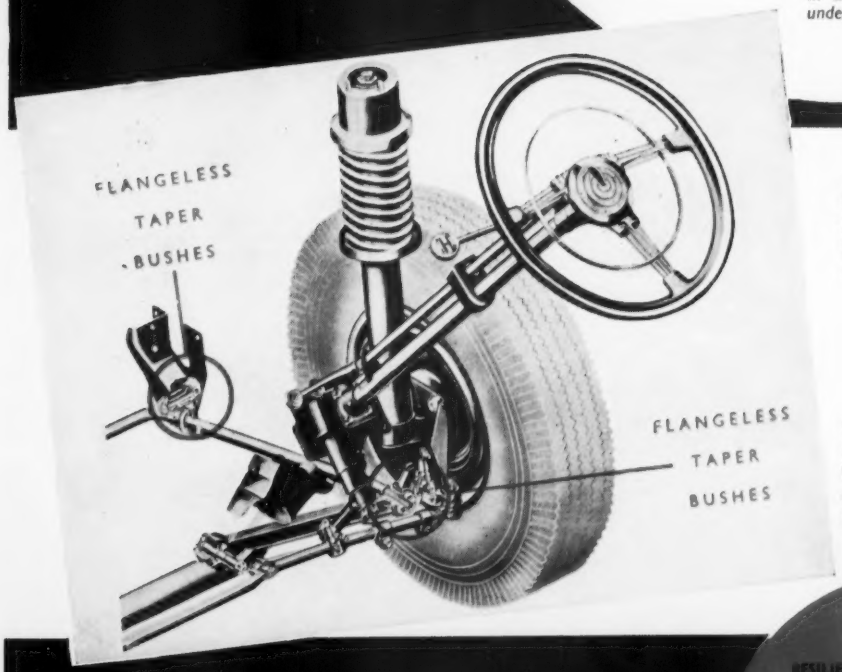

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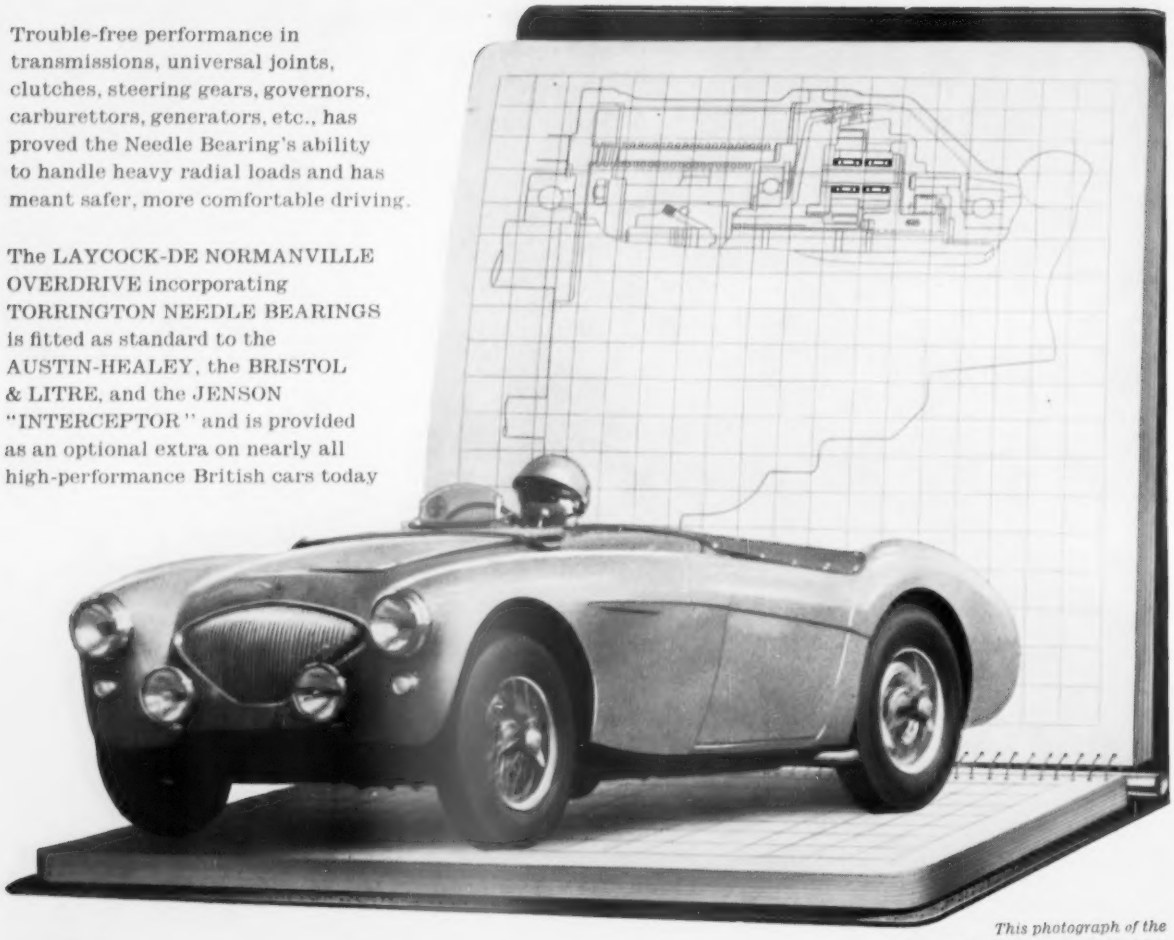

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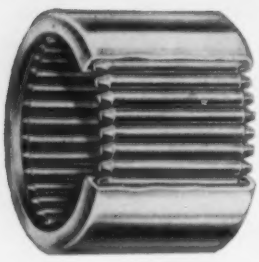

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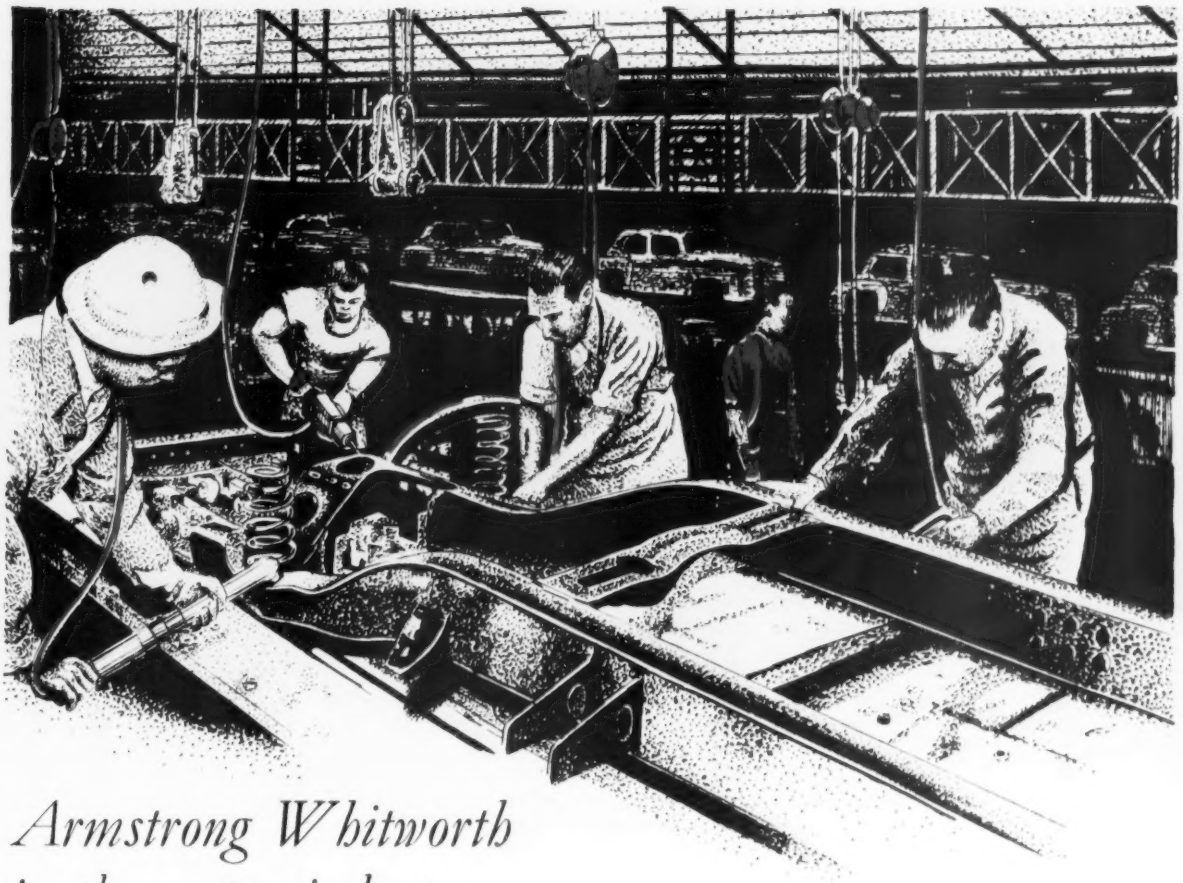

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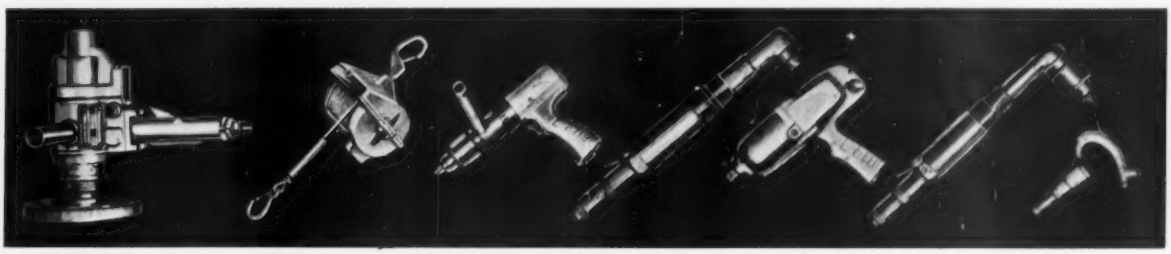

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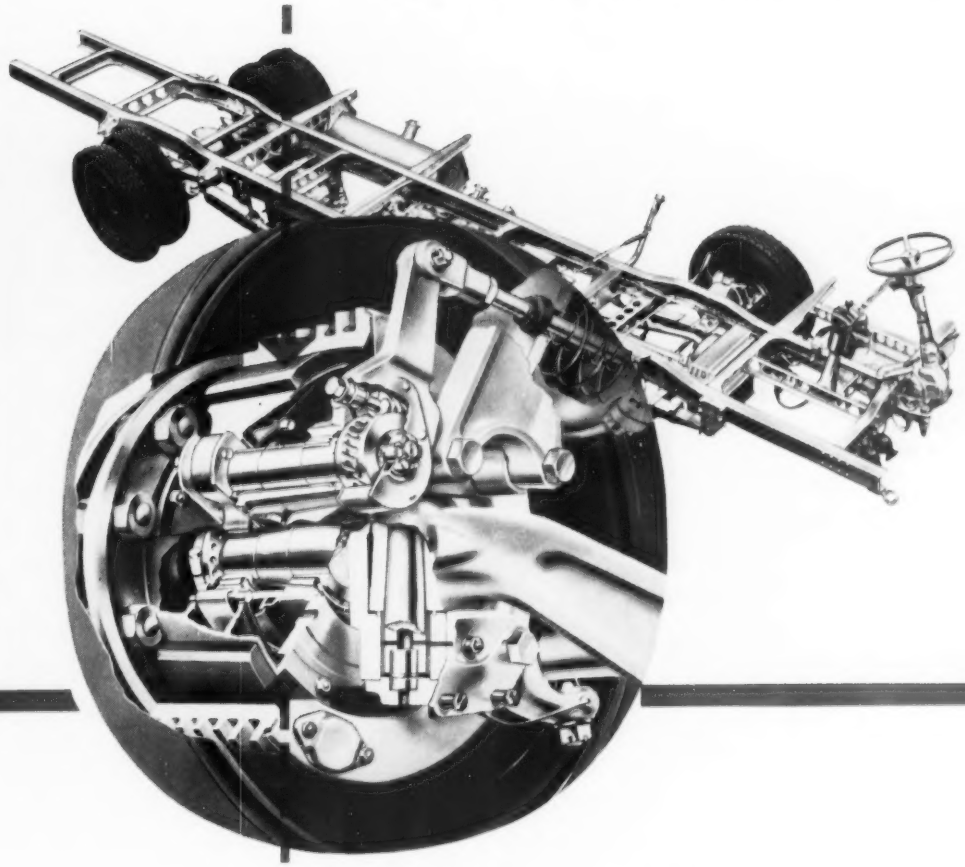

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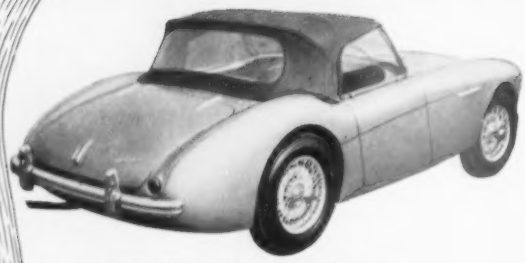
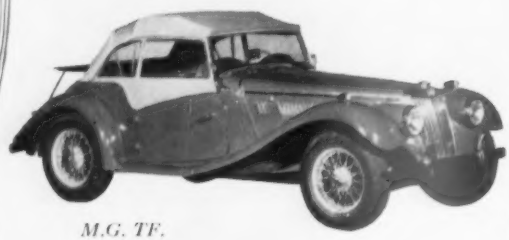


Austin-Healey One Hundred.



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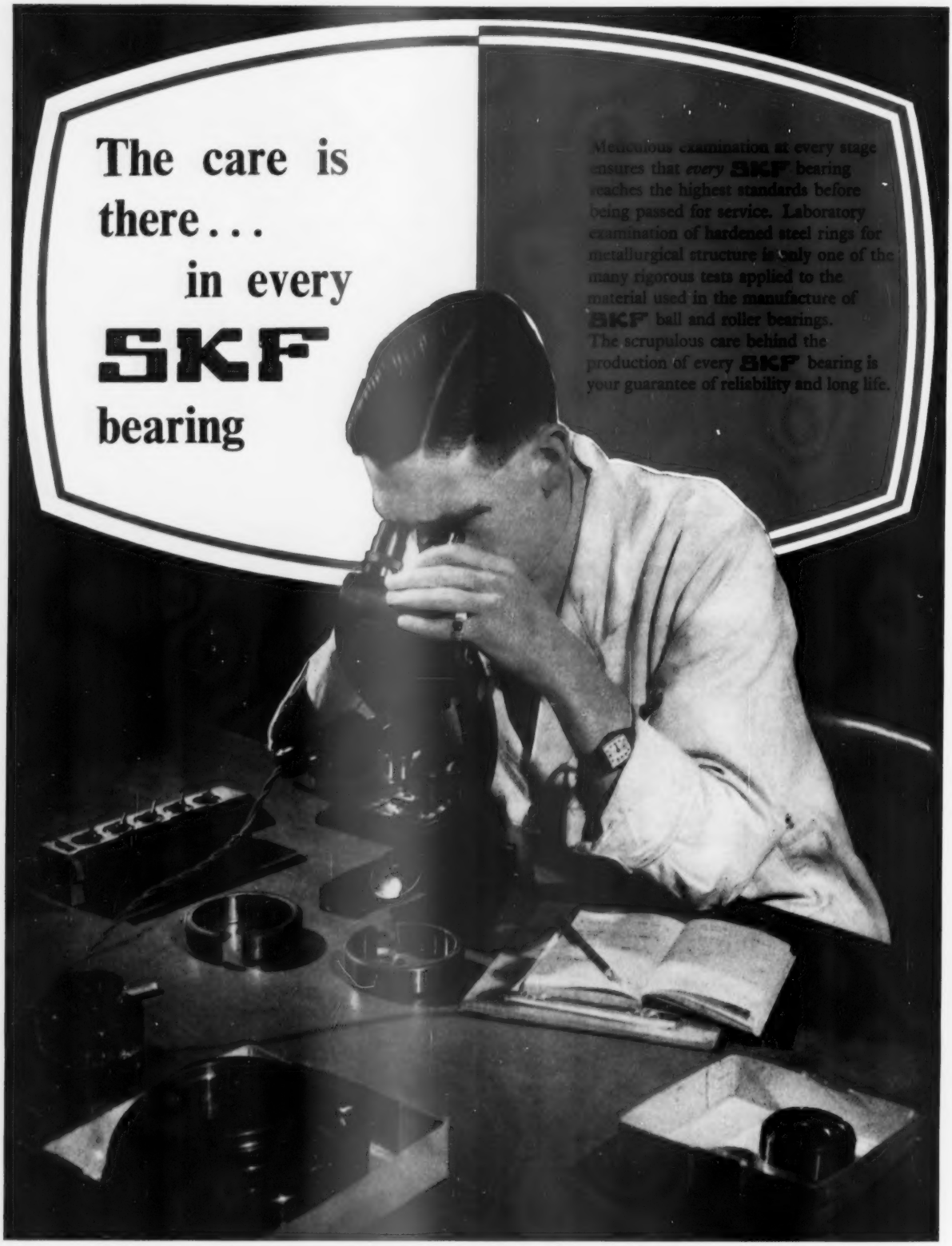
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C87

AUTOMOBILE ENGINEER

Design, Materials, Production Methods, and Works Equipment

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The London Show

THAT the 1954 Motor Show did not prove to be the occasion for any remarkable developments in design was in line with general expectations. Progress along conventional lines is evidently the immediate design and production policy of both British and Continental automobile manufacturers. Nevertheless many manufacturers exhibited completely new models, some were introduced at the show, others had been introduced earlier in the year.

In view of the reports that appear from time to time of an "economy" car, it is interesting that not one of the established manufacturers has attempted to enter this market, either by taking austerity to the extreme in interior trimming and fittings or by installing a very small engine as the power unit. In fact, the established manufacturers in this country show an opposite tendency by introducing such models as the new Hillman Minx de Luxe, the Ford Zodiac and the Vauxhall Cresta. Essentially, the Zodiac and the Cresta are versions of the Zephyr and Velox respectively, with added refinements at extra cost. The Hillman de Luxe is an improved version, with a completely new engine, of the older Minx, which is still available.

Obviously, market research has convinced the established manufacturers that the demand for the extreme "economy" car would not warrant the tooling costs that would be entailed in its production. This being so, there is little prospect of the successful production of a British "economy" car. A newcomer to the industry could reduce costs in one direction by using a very small engine and providing a bare minimum of amenities, but great capital resources will also be required if such a car is to be produced in the very large quantities necessary for low total cost per unit.

Engines

All the new British engines have overhead valves, and there are now but few British engines with side valves; this also applies to Continental engines. In America however, many of the current engine designs incorporate side valves. Manufacturers in this country, in contradistinction to some of their American counterparts, are not vying with each other regarding maximum b.h.p. from the power unit. Nevertheless, British engines do show a trend towards higher powers. This is effected by improved thermal and volumetric efficiency rather than, as is common in America, by increasing engine capacity.

Higher compression ratios, improved combustion chamber design to give more precise control of the combustion cycle and better breathing characteristics are all factors that have obviously been carefully studied in the search for higher power output from an engine of given capacity. What is possible without increasing engine capacity is strikingly illustrated by the Jaguar D-type engine, in which, by relatively simple modifications, the peak output has been raised from 160 to 210 b.h.p.

Carburation

Downdraught carburettors are fitted to the majority of present-day engines. This was also the case at previous post-war shows. There is, however, evidence of some degree of change in British practice, in that whereas previously British designers tended to follow American practice in specifying automatic chokes, there is now a tendency in some quarters to revert to hand stranglers. This difference in practice perhaps arises from a difference in car usage, which in this country, is in terms of much shorter individual journeys than are common in America. There is probably a case for using an automatic choke with over-riding manual control.

Induction systems have obviously received considerable attention. Wider use is now made of exhaust-heated manifold hot spots to give reduced warming-up time, improved fuel consumption and reduced cylinder bore wear. They usually incorporate some form of thermostatic control that reduces the hot-spot temperature after the initial warming-up is completed. There is a definite trend towards departing from the siamesed port arrangement in favour of separate inlet ports. This, in conjunction with improvements in the exhaust manifold arrangement, will tend to raise the volumetric efficiency.

The Mercedes-Benz 300B, the only production touring car with direct petrol injection, may be a pointer towards things to come, but we do not think it foreshadows any early increased use of direct petrol injection. While the results obtained with this engine are remarkably good—the maximum b.h.p./displacement ratio is almost equal to that of the Jaguar D-type engine—the first cost of the injection equipment is probably much too great to be economically competitive with the carburettor.

Transmissions

Fully automatic transmissions appeared for the first time on three additional British cars. Of the newcomers, probably the most interesting was the installation on the Lanchester Sprite. The other British cars with automatic

transmissions are all over 3 litres capacity, but the Sprite has a power unit of only 1·5 litres capacity. An additional point of interest is that the Sprite transmission is completely British in design. The performance of this new transmission will be watched with interest, but it does appear that for cars of medium power, two-pedal control is more likely to come through the medium of an electric-magnetic clutch of the Smith-Eaton type. Of more immediate interest and importance to the average motorist is the increasing use of Laycock-de-Normanville overdrives, which are standard equipment on several British cars and are optional for several others. At the high cruising speeds which are now common, the overdrive has much to commend it, since it reduces the stresses on the engine at high speed, thereby increasing life.

Apart from the hydro-pneumatic system now available for the six-cylinder Citroen, the past twelve months have not seen any marked changes in suspension design. As in 1953 approximately 96 per cent of British and Continental cars have independent front suspension, and 70 per cent have systems that embody double wishbones and coil springs. Independent rear suspensions are still rare.

Power steering

Hitherto, power-assisted steering for passenger cars has been confined to vehicles of American manufacture, but a British system, the Girling, is now available. It is said to have great sensitivity of operation. Except for its advantages on the few large British cars, the potential demand for power-assisted steering must remain a matter for speculation. Whether the advantages to be gained, even on the large cars, will warrant the introduction of an additional mechanism is greatly in doubt.

It is a matter for some surprise that disc brakes have won acceptance for only two cars, both in the super-sports class. The high speeds of which some of the present-day large saloon cars are capable, do call for the most efficient possible braking system, and the adoption of disc brakes for such cars must surely come before long. Meanwhile, the hydraulically operated drum brake with two-leading shoes at the front and leading and trailing shoes at the rear is general British practice.

As always, there were some really magnificent examples of the specialist coachbuilder's art, but with these we are not concerned here. They are discussed in some detail elsewhere in this issue. In line and styling, the new low and medium price British cars in general followed the established practice of the various manufacturers. Whether a particular line is pleasing or not is largely a matter of opinion, and it would probably be unwise to make too sharp a departure from accepted practice when introducing a new model that is intended to have great popular appeal.

Bodywork

Although there are no grounds for complaint about the general appearance of cars in the showroom condition, there is room for detailed criticism. Chromium plating is a case in point. Great use is still made of chromium plating for decorative purposes; whether this is necessary or advisable, is arguable, but there cannot be the slightest doubt that if it is used, it should be better in quality than much of the plating on present-day cars. This is perhaps a matter of economics, and if better quality chromium plating cannot be produced without an appreciable rise in costs, it would be better to eschew plating and rely on line, and not decoration, to produce a pleasing result.

It was pleasing to see that on some models, greater attention has been paid to the question of visibility from the driving seat. However, much still remains to be done before it can be said that visibility is all that can be desired. The changes made have been mainly concerned with improving rear visibility, with larger rear windows reducing the extent of the blind spot on the off-side rear quarter. This is the blind spot of which the average motorist is most conscious, but in heavy traffic the off-side front pillar of some saloon cars can cause an even more disturbing blind spot when right-hand turns are being taken. This is a point that should receive attention in future models.

In the present stage of development, plastics bodies cannot compete with conventional pressed steel bodies for large quantity production, but they have certain advantages for relatively small scale output. Two British firms have made some attempt to exploit these advantages. On the new Hunter, Singer have made a restricted use of plastics by employing them for the bonnet and bonnet valances. In view of the difficulties that have been experienced by General Motors in America in producing a car with an all-plastics body, this modest start by Singer is probably fully justified. A more ambitious incursion into the use of plastics is exemplified by the Jensen saloon with an all plastics body.

Recent statements concerning large expansions of production facilities show that those who direct the fortunes of the British automobile industry have great faith in the industry's future. The 1954 Motor Show certainly provides reasons for believing that this faith is justified.

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EARLS COURT EXHIBITION

A Review of Design Trends

ENGINES

Increased Thermal Efficiency and Durability, Easier Servicing

AT Earls Court this year, the basic design of engines shown for the first time generally followed conventional practice. While performance remains the governing factor in design, ease of production and servicing have received adequate attention. In parallel with this, there is an extension of the policy of rationalization as applied to engines produced within manufacturing groups. Examples of this are the engines of the B.M.C. group, where five basic engines are installed in eleven cars, and again in the Rootes Group, where the 2¼ litre engine is now installed in the Humber Hawk and in the Sunbeam. To suit the requirements of the individual cars, different carburettors are fitted and the compression ratios are altered.

Perhaps the most marked trend is in stroke : bore ratios, which in general are approaching unity. This change, besides leading to compactness and lightness, has influenced other factors such as combustion chamber design, valve sizes and disposition, and crankshaft and connecting rod layout. The effect on layout in some instances has been to make it necessary to use offset connecting rods to avoid increased crankshaft length. This is exemplified in the B.M.C. A90 power unit, and the Aston Martin 3 litre engine.

Performance

Although there are no indications of a "power race" comparable with that in the United States of America, there is a steady trend towards higher powers. They are being obtained by higher thermal and volumetric efficiencies rather than by the use of larger engines. In fact, in some cases, newly introduced engines of greater efficiency are smaller than those they supplant. This is true of the Lanchester Sprite, in which the 1·6 litre engine takes the place of the previous 2 litre unit.

In general, increased thermal efficiency is obtained firstly by increasing the compression ratio to about 7 to 7·5 : 1, for cylinders of 3 to 3½ in bore. These figures, of course, do not apply to competition models, in which the ratios are mostly from 8 to 9 : 1. All these increases have been made possible not only by the ready availability of fuels of high octane value, but also by improvement in combustion chamber design, which has had the further effect of directly raising thermal efficiency.

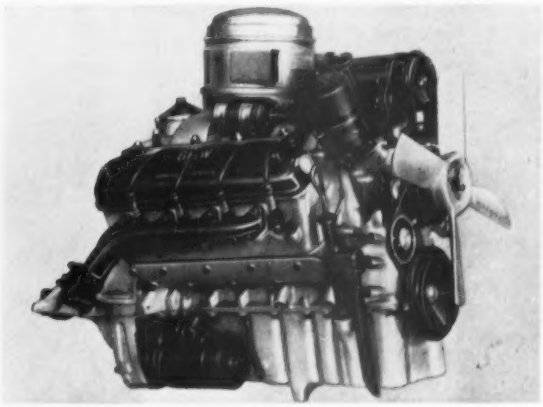
The principal aims of designers have been at obtaining more precise control over the combustion process by alteration to the chamber contours; at regulating turbulence by the amount of squish applied; and at the suppression of detonation and pre-ignition by the incorporation of a quench area and by improved cooling of the exhaust valve seats and sparking plug bosses. The application of these principles can be seen on the new B.M.C. A90 and on the latest Daimler and Hillman engines. Efforts to raise the volumetric efficiency have followed the normal development pattern : that is, first the gas flow to the inlet and from the exhaust valves is improved, and then the flow through the valves is increased by alteration to the valves, their lift and timing.

In conformity with this trend, the side valve layout has been abandoned in favour of the overhead valve arrangement with its higher charging efficiency. This change has also been encouraged by the higher thermal efficiency obtainable with the more compact combustion chamber of the overhead valve layout. To improve further the gas flow conditions, individual porting is being more widely adopted. This is because siamesed ports tend to promote eddies and to lead to interference, from one port, with the entry of the charge through the other. This trend towards individual porting is illustrated on all the new engines.

Further improvement in breathing has been effected by employing larger valves; this has been facilitated by the reduction in stroke : bore ratios. In some engines, however, the enlargement has been effected without changing the cylinder dimensions. In the Jaguar, for example, the effect has been obtained by two measures; first, the adoption of a higher valve lift, and second, the enlargement of the valve throat diameters. Together with slight alterations to the cam profiles and combustion chamber shape, the first measure increased the power from 160 to 190 b.h.p. and the second further increased it to 210 b.h.p.

In most of the new engines at the Show, the ratios of valve throat diameter : cylinder bore are approximately 0·45 : 1 for the inlet valves and 0·40 : 1 for the exhaust valves. The ratio of valve lift : throat diameter remains about the same as before at 0·25 : 1, but when a common lift is used, the ratio

A somewhat unusual water off-take has been adopted in the Austin-Healey 100S



The B.M.W. V8 engine is a compact unit incorporating a number of unconventional features

is slightly lower for the inlet and higher for the exhaust valves.

A new feature is the increasing attention being paid to the design of exhaust manifolds. Whereas in the past it has been common practice on six-cylinder engines to employ two manifolds to avoid blow-over between cylinders adjacent in the firing order, the same principle is now applied to a number of four-cylinder units. On the Lanchester Sprite this principle is exemplified in a dual manifold connecting ports 1 with 4 and 2 with 3 and discharging through separate downtakes though with a common flange. A further extension of this principle is the employment of two separate manifolds connected to independent exhaust systems with two tail pipes, as on the Alfa Romeo 1900 Sprint.

Mean piston speeds at maximum b.h.p. appear to have stabilized at about 2,500 ft/min, which for some years has been regarded as the optimum figure for the normal car. In the six new engines, the average value is 2,465 ft/min. The general tendency for this figure to vary with the stroke: bore ratio is clearly exemplified, the variation being between 2,200 ft/min on the Hillman Minx overhead valve engine, with a stroke:bore ratio of 1:1, to 2,840 ft/min on the Daimler Regency Mark II with its corresponding ratio of 1·30:1. Where alternative, high output variants of engines are also produced, the piston speed in most instances is raised by 10 to 15 per cent. The upper limit is in the D type Jaguar, with a figure of 4,180 ft/min. The A.C. Ace is an extreme example of the policy of avoiding interference between exhaust impulses and of utilizing their inertia effect to improve scavenging. Tuning by adjusting the length of the pipes can have a beneficial effect at certain speeds.

Durability

Durability, as expressed in terms of overhaul life, has been thrown into greater prominence by the more arduous operating conditions overseas and has dictated a number of design changes in some makes of car. On the other hand, many of the measures new to these models have been established practice for some time on others. Improvements have also been necessitated by the higher mechanical and, particularly, thermal loading consequent on the increases in specific power.

A number of these features are aimed at reducing cylinder bore wear. The more fundamental approach to this problem is to be seen in attempts to reduce cylinder barrel distortion to a minimum. This is tackled in two ways; the first is by arranging the cylinder head studs uniformly around the bore and by keeping the stud bosses well clear of the cylinder barrel. The second is the maintenance of a uniform temperature around the cylinder barrels by the provision of an adequate water space between them. Considerable improvement has also been obtained by the adoption of overhead valves since, in side valve engines, the hot region adjacent to the exhaust valve on one side of the cylinder may lead to distortion. A more uniform temperature gradient along the length of the barrel is now obtained by the almost universal adoption of jackets that at least extend over the whole length swept by the piston rings.

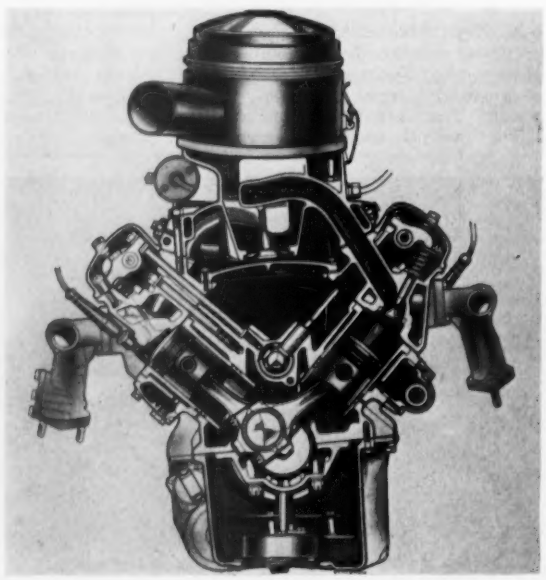
These trends are illustrated in some degree by all the new engines, the B.M.W. V8 being the only one incorporating wet liners and so joining Citroën, Renault and Standard in this practice. Dry liners are employed on the 3½ and 4½ litre Daimlers.

To reduce bore and ring wear, there is a growing trend towards the use of chromium plating for the finish of the peripheral face of the top piston ring as this measure is less expensive than chromium plating the bores. Vauxhall, among other manufacturers, have adopted this practice. There is also a tendency to increase the number of piston rings to four. It is usual to fit all of them above the gudgeon pin, so that the more severe oil control obtained by the employment of the extra ring will not result in the piston skirt being under-lubricated and consequently scuffed or scored.

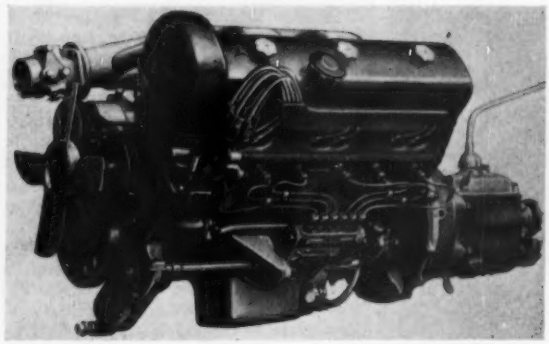
Where this practice is adopted, it has become customary to fit taper faced rings in one or both of the two intermediate grooves to avoid increasing the running-in time. Four rings are employed on the latest B.M.C., Daimler, Lanchester and B.M.W. engines. Improvement in oil filtration is another feature that has been introduced to reduce bore wear. It also has beneficial effects on all rubbing surfaces. There is a move to fit filters of larger areas. In most of the new engines full flow filtration has been adopted; thus the element of chance, so far as the introduction of large solid particles into the bearings is concerned, has been obviated. The efficiency of the oil filter is of greater importance when lead bronze is employed instead of white metal in the big end and main bearings. This is because of its poorer embedability.

Where loading is high, the increased cost of the bearings and the attendant increase in cost of the crankshaft is warranted by the permissible reduction of bearing area. If the full benefit of increased life is to be obtained, it is necessary to use a hardened shaft. Hardening is in some instances effected by nitriding, in which case a con-

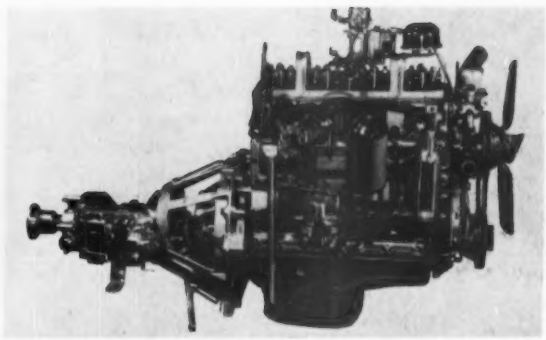
On the Borgward 1½ litre engine the oil filter is mounted high up at the rear where it is readily accessible for servicing



An interesting feature of the B.M.W. V8 unit is the compensating device for minimizing changes in tappet clearance



Bosch petrol injection equipment is fitted on the Mercedes Benz 300SL



The new overhead valve engine for the Hillman Minx develops 43 b.h.p. at 4,400 r.p.m.

siderable gain in fatigue strength is obtained. However, neither nitriding nor lead bronze bearings are widely used. Bearings of this type are fitted to the D type Jaguar, Austin-Healey 100S and 1,100 cm³ Coventry Climax; a nitrided shaft is employed in the Austin-Healey. Doubtless, where economics and operating conditions justify the increased cost, these practices will be extended to meet the requirements dictated by the higher gas loading resulting from increased compression ratios and inertia loading consequent on the reduction in stroke:bore ratio. Operating conditions for bearings have been further improved by the stiffening of crankshafts, again mainly as a result of shortening strokes. This has reduced the tendency to edge loading. An appreciable crank pin journal overlap is now common practice and on the basis of the 1955 designs appears to be generally of the order of 15 to 25 per cent, expressed in terms of the journal diameter.

The increased lead content of fuels has resulted in changes in the design of exhaust valves, seats and ports to reduce the tendency to lead attack. Control of valve temperatures is most important under these conditions as there appears to be a critical temperature for the material, above which lead attack is severe.

The principal methods of countering lead attack are: the use of a resistant steel for the valve, design to reduce valve temperatures, prevention of the build up of deposits on the valve and seat, and protection of the valve seating and head. The first two are exemplified by the use of XB and KE 965 steels, while all new designs exhibit features to maintain relatively low valve temperatures. These include individual porting with free flow profiles, jet tubes or other devices in the jacket to direct water on to the valve seats, water jackets extended down to the seat, and generous water space provided around the valve guide boss and between adjacent exhaust ports. Valve guides directly in contact with the water without guide bosses continue to be used by Aston Martin and Lagonda.

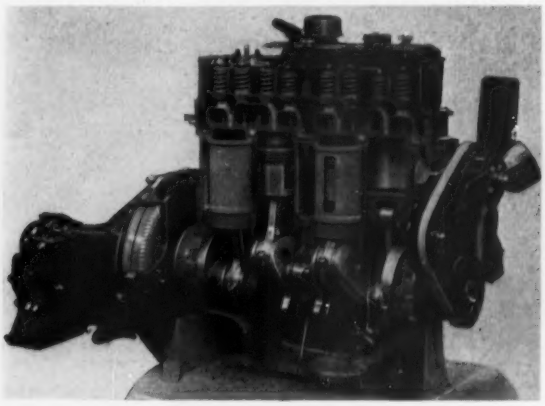
There is now a considerable extension of the trend noted last year towards the general adoption of narrow section V-belts because of their ability to carry higher specific loadings. While there does not appear to be any change in principle concerning resilient engine mountings, there is a reversion towards the use of softer mountings. In most instances, where a change has been made, a larger volume of rubber is employed in the mounting. Where the popular V-arrangement is used, the rubber at the upper end of each unit in some instances is turned over at right angles to form a cushioned limit stop. The softening of the mountings calls for the use of a tie rod to provide more positive fore and aft location to prevent clutch judder during take-up. This is not necessary if hydraulic clutch actuation is adopted.

There is a commendable tendency to simplify servicing operations, as can be seen by the greater accessibility of tappets and oil filters. In many cases the filter is mounted high on the engine and can be serviced from above. Lifting eyes are now a feature on some engines.

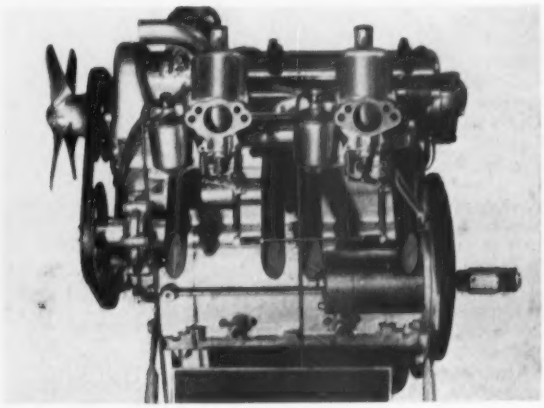
British Motors Corporation

The new B.M.C. engine installed in the Austin Westminster and the Wolseley Six-Ninety is the third of the series to be designed and developed and is known as the Series C. This engine differs only slightly for the two installations. In the Westminster it is fitted with a single Zenith downdraught carburettor, and in the Wolseley, it has two S.U. horizontal instruments.

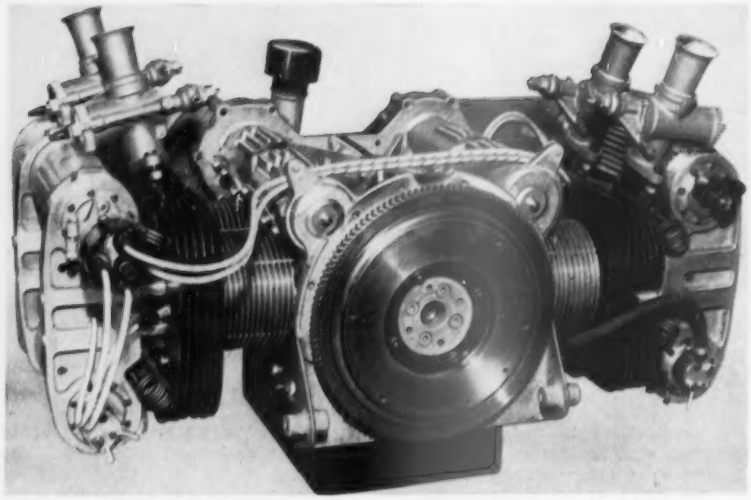
It is a six-cylinder unit of 3·125 in bore and 3·50 in stroke. This represents a stroke : bore ratio of 1·12 : 1, and gives a capacity of 2,639 litres. With a compression ratio of 7·3:1 the maximum powers developed are 85 b.h.p. at 4,000 r.p.m. in the Austin and 95 b.h.p.



Wet liners are employed in the Renault 2 litre engine which was displayed in sectional form



A single overhead camshaft layout has been adopted in the Coventry Climax four-cylinder engine



Chain-driven overhead camshafts are employed on the Kieft horizontally opposed, four-cylinder air-cooled engine

at 4,500 r.p.m. in the Wolseley installation. The corresponding maximum torque and b.m.e.p. figures are 130 lb-ft and 120 lb/in², and 145 lb-ft and 133 lb/in² respectively, at 2,000 r.p.m.

Specific powers of 32·2 and 36·0 b.h.p/litre for piston loadings of 1·91 and 2·06 b.h.p/in² are obtained respectively. The torque ratios, that is, the ratios of maximum torque to those at maximum power, are 1·16:1 and 1·30:1; and the speed ratios, that is, the ratios of speeds at maximum power to those at maximum torque, are 2·00:1 and 2·25:1. The maximum piston speeds are 2,330 and 2,620 ft/min for the two versions.

In common with the two earlier B.M.C. engines and with currently produced Austin units, the Weslake combustion chamber is used. It has a heart-shaped plan-form, with a projection between the valves, and is used in conjunction with a piston with a concave crown. Split skirt pistons fitted with one rectangular section and two taper faced compression rings are used, while oil control is by a normal slotted ring. All the rings are fitted above the gudgeon pin. This should ensure adequate lubrication of the piston skirts.

Connecting rods of orthodox design are used. White metal lined bearing shells are fitted in the big ends, which are split at right angles to the axis of the rod. In the small ends, the gudgeon pins are clamped. The ratio of connecting rod : crank radius is approximately 3·7 : 1.

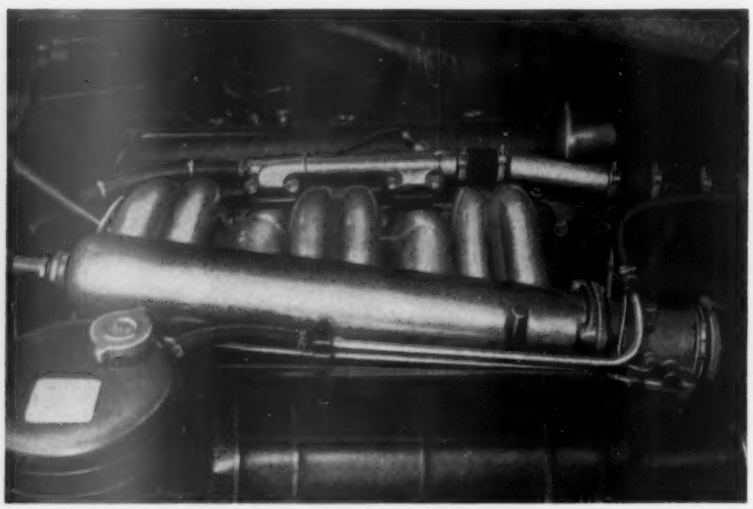
The valve gear follows previous B.M.C. practice: the cams of composite flank profile, actuate the valves through barrel type tappets, in the top of which the push rods are seated. Single valve springs are employed. Sleeves are fitted to the inlet valve spring retaining caps to prevent oil running down the valve stems and causing high oil consumption and smoky exhaust. The throat diameter of the En 52 inlet valve is 1·375 in, while that of the En 57 exhaust valve is 1·118 in. These dimensions are 44 per cent and 36 per cent of the cylinder bore. The valve lift, of 0·315 in, is common to inlet and exhaust. It gives ratios of lift : throat diameter of 0·23 and 0·28 : 1 respectively. The valve timing is normal for this class of engine and is 5 deg, 45 deg, 40 deg, 10 deg, giving a 15 deg overlap. To improve gas flow and also to reduce valve temperature, individual porting has been adopted. The gas is conducted through two, three branch manifolds. A straight rake type of induction manifold is employed. It is cast in the head, in which the individual inlet ports lead steeply down to the valves. This arrangement is more fully described in the section on carburation.

A single casting forms the cylinder block and crankcase, and the counter-balanced crankshaft is supported in white metal lined steel bearing shells in the end walls and two intermediate webs. The water jackets extend the full length swept by the piston rings. Water spaces are incorporated between the barrels. The discharge from the water pump feeds a gallery cast along the top of the block on the carburettor side of the engine. From this, the water is discharged through a series of inclined ports into the head jacket to give a measure of directive cooling for the exhaust valve seats and ports. The water space is extended down between the ports to the valve seats.

B.M.W.

A new V8 engine of 2,580 litres capacity is installed in the B.M.W. 502 car. This engine has a bore and stroke of 2·913 in and 2·953 in respectively (74 mm × 75 mm). With a compression ratio of 7 : 1, it develops a maximum power of 105 b.h.p. at 5.000 r.p.m. The maximum torque of 139 lb-ft is equivalent to a b.m.e.p. of 133 lb/in². Although the specific power is relatively high at 40·7 b.h.p/litre, the moderate piston loading of 1·97 b.h.p/in² reflects the low stroke : bore ratio which is 1 : 1. This factor is also responsible for the moderate piston speed of 2.470 ft/min at the rotational speed of 5,000 r.p.m. The torque ratio is 1·27 : 1.

A single casting forms the crankcase and two banks of cylinders disposed at 90 deg. The wet liners are located by a top flange and protrude through apertures, machined in the bottom of the jackets, into the crankcase. Three water trap grooves are turned in the bore of each aperture. A hole is drilled between the centre one and the outside of the crankcase to allow any water that may leak past the first seal to drain off. The water pump discharges into one of two cells in the block casting. These cells are closed by bolted-on covers and are positioned one on each side of the



The engine installation in the Mercedes Benz 300SL, showing the air intake manifold and branches

engine. An oil-to-water heat exchanger is located in one. From the cells the water passes through holes into the base of the jackets round the cylinders.

Wedge-shaped combustion chambers are used, in conjunction with pistons with slightly domed crowns. This provides a moderate quench area. The arrangement of the sparking plugs is somewhat unusual. Although they are installed on the side of the chamber remote from the quench area, they are parallel to the cylinder axes when viewed in cross section. This has the advantage that the top of the plug extends up from the cylinder head instead of projecting from the side, as is usual with this form of chamber, and is good from the point of view of accessibility.

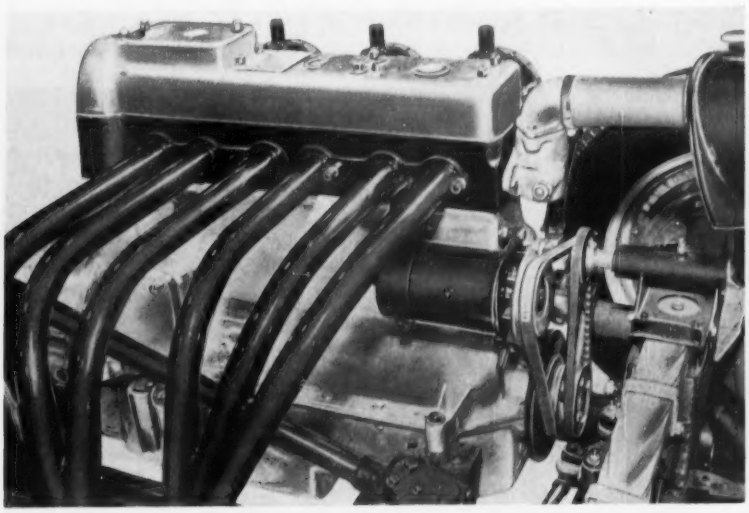
Three compression rings and one oil control ring, all above the gudgeon pin, are fitted to the light alloy pistons. The fully floating gudgeon pins are secured by circlips in the usual manner. Orthodox H-section connecting rods are employed, the big ends being split at 90 deg to the axis of the rod. The two cylinder banks are offset longitudinally relative to one another to accommodate the side-by-side connecting rods. A connecting rod : crank radius ratio of 3·8 : 1 has been adopted.

The valve gear is of the conventional push rod type, and the single camshaft is directly over the crankshaft, in the base of the vee of the main casting. An unusual feature is a temperature compensation device, which is similar in principle to that employed for many years on Bristol aero-engines to maintain constant tappet clearances. The rocker fulcrum shaft is mounted on short beam type brackets across the head. The outer ends of these brackets are held down by studs in the cylinder heads, but their inner ends are clamped between a nut and collar formed on the upper end of a long tie rod passing through a clearance hole in the overhanging part of the head. This tie rod is screwed into the base of the vee of the crankcase casting. Compensation is effected by the lift of the rocker fulcrum resulting from differential expansion between the block and the tie rods. The tie rods are mounted close to the push rods so that the expansion of the two sets of components relative to the head is more or less identical.

Another unconventional feature concerns the mounting of the Solex, dual choke downdraught carburettor. The induction manifold is inside the vee and feeds ports on the inner sides of the cylinder heads. Bolted directly to it is the carburettor, which is surrounded by a vertical flange cast integrally with the manifold. On top of the carburettor is a cylindrical air cleaner. This has a deep skirt projecting downward and spigoting into the flange on the manifold. It is secured to the flange by three toggle action clips, and thus completely encloses the carburettor.

Air is fed to the cleaner via a pipe through which air is drawn from the front of the car. As the air enters the cleaner assembly it impinges on the float chamber of the carburettor, round which it circulates before being drawn up through the filter element. Thus, there should be little tendency to vapour lock in the carburettor when the car is moving. However, it would appear that this trouble might still occur in hot weather and particularly at high altitudes immediately after the engine is switched off.

The water pump is mounted in the front face of the crankcase and is driven by a narrow V-belt from a pulley on the crankshaft damper. The usual form of triangulated drive is employed, but the third pulley is a jockey mounted on an adjusting plate for belt tensioning. A second pulley on the water pump spindle drives the dynamo, pivot-mounted above. The oil filter, held down by a central bolt, is mounted vertically at the rear of the crankcase above the longitudinal axis of the engine, with the bolt head and cover at rocker level. Two rear off-take, exhaust manifolds are bolted to the outside of the cylinder heads.



On the A.C. 2 litre engine, the individual exhaust branches are of considerable length

Overhead valve Hillman Minx

The new Hillman Minx engine is of the square type, having a bore and stroke of 3 in. It is a four-cylinder unit and has a swept volume of 1·390 litres. With a compression ratio of 7 : 1 the maximum power developed is 43 b.h.p. at 4,400 r.p.m., and the maximum torque and b.m.e.p. are 66·3 lb-ft and 118 lb/in² respectively at 2,200 r.p.m.

These figures represent a specific power output of 31·0 b.h.p/litre and a piston loading of 1·52 lb/in². The maximum piston speed is 2,200 ft/min which, in addition to the piston loading, illustrates the effect of the low stroke : bore ratio. A torque ratio of 1·28 : 1 and a speed ratio of 2 : 1 are obtained.

An offset, bath-tub type of combustion chamber with a considerable quench area is incorporated. The pistons, connecting rods and three-bearing crankshaft are of normal design, although the intermediate of the three piston rings is taper faced while the bottom one is a slotted oil control ring. As the connecting rod length between centres is 5¾ in, the connecting rod length : crank radius ratio is 3·82 : 1. All bearings, including those of the camshaft, are of the white metal lined steel shell type. The overlap of the crank pins and main journals represents 25 per cent of the journal diameter.

A cast iron camshaft driven by a duplex chain with spring-blade tensioner is employed. The valve gear is of normal design: the ratio of the inlet valve throat : cylinder bore is 0·42 : 1, and that for the exhaust is 0·33 : 1. A common lift of 0·329 in has been adopted. This gives lift : throat ratios of 0·26 : 1 for the inlet and 0·33 : 1 for the exhaust. The valve timing is 11 deg, 55 deg, 53 deg, 13 deg, giving an overlap of 24 deg. Each valve is in an individual port. Adequate cooling of the exhaust valves is ensured by thimbles inserted in the cylinder head and directing water streams on to the valve seats.

Generous water jacket space is provided round all ports. Full length jackets also surround the cylinder barrels. A full flow oil filter is mounted high on the offside of the engine. The canister seats on a casting at the bottom of the filter instead of at the top, as is more usual. Thus some loss of oil may be expected when the element is changed.

Daimler

A further example of rationalization is provided by the three new engines developed by the Daimler Co. Ltd. These are the 3½ and 4½ litre Daimler units and the Lanchester Sprite. The Daimler engines have a common stroke. The engine installed in the Sprite has the same bore and stroke dimensions as the Daimler Conquest unit and, although embodying several new features, may almost be regarded as a four-cylinder version of that unit.

In the two new Daimler engines, well proved engineering practices based on the firm's experience over many years have been followed. The combustion chamber is approximately D-shaped in plan and its roof slopes down from the plug to control the rate of advance of the flame path. It terminates in a step over the piston crown to provide an appreciable quench area. In each cylinder, this region as well as the exhaust valve seat is well cooled by a jet of water issuing horizontally from a thimble inserted from the underside of the cylinder joint face.

The parallel valves are inclined from the vertical, the angle being that of the slope of the combustion chamber roof. Valve operation is by an orthodox layout of rockers and push rods with chilled cast iron, bucket type tappets.

White metal lined, steel shell type bearings are used to carry the crankshaft, big end and camshaft journals. The four-bearing counterbalanced crankshaft is fitted with a rubber-to-metal bonded torsional vibration damper. T-slot pistons are employed and they have four piston rings, the top compression ring being chromium plated and the two remaining ones taper faced. A slotted oil control ring is fitted.

Dry liners are pressed into the block and the cylinder jacket extends the full length swept by the piston rings. Diagonally split big ends enable the rods to be drawn up through the cylinder bores. The connecting rod: crank radius ratio is approximately 3·7:1 on the 3½ litre unit. Both the big end and the dowel located bearing caps are retained by set bolts. A gear type pump supplies oil through a full flow filter to the lubrication system.

Individual valve ports are employed. Two, three branch exhaust manifolds are bolted to exhaust pipes, which unite some distance back from the downtake flanges. This gives a considerable measure of flexibility and allows the manifolds to expand and contract without fracturing the flanges. The Daimler water jacketed induction manifold is fed from two S.U. horizontal carburettors.

Three coils serve the D.K.W., three-cylinder two-stroke engine and a large baffle prevents air heated by the exhaust manifold from passing through the rear-mounted radiator

The 3½ litre engine is built in two forms, one installed in the Regency Mark II saloon and the other, a high output version, in the Sportsman saloon. Both are six-cylinder units with a bore and stroke of 3·25 × 4·25 in. This gives a swept volume of 3·468 litres and a stroke:bore ratio of 1·3:1. The standard version, with cast iron cylinder head, has a compression ratio of 6·5:1 and develops 107 b.h.p. at 4,000 r.p.m. Its torque output is 183 lb-ft and a b.m.e.p. of 131 lb/in² is obtained at the low speed of 1,600 r.p.m.

A light alloy head is employed on the high powered version, which has a compression ratio of 7·6:1. The power output is 140 b.h.p. at 4,400 r.p.m., and a maximum torque of 202 lb-ft, representing a b.m.e.p. of 145 lb/in² at 2,500 r.p.m., is obtained. The specific output of these engines is 31·0 and 40·0 b.h.p/litre for piston loadings of 2·15 and 2·81 b.h.p/in² respectively. At maximum b.h.p., the piston speeds are 2,840 and 3,120 ft/min.

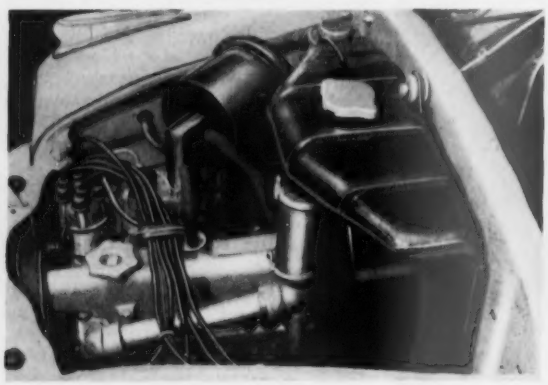
While the torque ratio of the standard engine is high at 1·30:1, that of the sports version is more normal at 1·22:1. The speed ratio of the two models is 2·50 and 1·76:1. In view of the high speed ratio of the Regency saloon model, good bottom end performance is undoubtedly obtained.

The 4½ litre engine, as previously mentioned, has the same stroke as the 3½ litre unit. With a bore of 3·75 in and a stroke of 4·25 in, the stroke:bore ratio is 1·31:1. The engine capacity is 4·617 litres, and the compression ratio is 6·53:1. Maximum power is 127 b.h.p. at 3,600 r.p.m., when the piston speed is 2,560 ft/min. In this larger engine the specific power is 27·5 b.h.p/litre with a piston loading of 1·94 b.h.p/in².

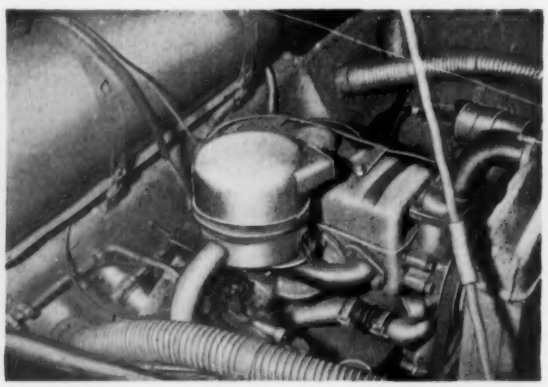
In the four-cylinder Lanchester Sprite engine, the principal departures from Daimler practice concern the induction and exhaust systems. A straight rake induction manifold is employed. Individual branches feed each inlet port, and a Zenith down-draught carburettor is fitted. The exhaust manifold, though cast in one unit, is in two independent sections, one is connected to exhaust ports 1 and 4, and the other to ports 2 and 3. Each section discharges through a separate down-pipe. These, however, are side by side, and have a common flange. The two exhaust streams are united in a common pipe below the downtake flange.

The engine has a 3·00 in bore and a 3·50 in stroke, which represents a capacity of 1·622 litres and a stroke: bore ratio of 1·17:1. In the inlet and exhaust ports, the valve throat diameters are 1·437 and 1·406 respectively. From these figures it can be seen that the throat:bore ratios are 0·48 and 0·47:1.

The maximum figures for power, torque and b.m.e.p. are 60 b.h.p. at 4,200 r.p.m., and 84 lb-ft and 130 lb/in² at 2,800 r.p.m. From these figures the specific power values of 36·9 b.h.p/litre and 2·12 b.h.p/in² piston area are obtained. The torque



Interesting features of the Fiat 500 engine installation, with its rear mounted radiator, are the fan drive and water off-take pipe arrangement



On the Skoda engine a horizontal carburettor is employed and the exhaust manifold is above that of the inlet. Quick release toggle clips secure the top cover of the air silencer

and speed ratios are 1·11 and 1·50:1, and the maximum piston speed is 2,450 ft/min. With crank pin and main journal diameters of 2·0 in and 2·25 in respectively, the overlap is 15 per cent of the main journal diameter.

Austin-Healey

The engine in the Austin-Healey 100S provides a good example of the degree to which an engine of straightforward design can be developed if the initial basic conception is sound. This engine is based on the four-cylinder Austin A90 unit, which developed 88 b.h.p. at 4,000 r.p.m., but there has been considerable departure from the original specification. Although the original monobloc crankcase casting is still employed, a new design of cylinder head is used. This change was necessary to overcome the restriction imposed on enlargement of the ports by the proximity of the push-rod tubes. In the new head, the ports have been moved across to the off-side of the head while the push-rods are retained in their original position.

As the original cylinder dimensions are retained, the engine capacity remains unchanged at 2·66 litres. The bore and stroke are 3·438 in and 4·375 in respectively, and the stroke: bore ratio is 1·28 : 1. The compression ratio has been raised to 8·30 : 1; the volumetric efficiency raised by enlarging the valve throat dimensions to 1·562 in and 1·375 in for inlet and exhaust respectively, with a common lift of 0·435 in; and the porting improved. As a result of these changes, the maximum power is now 132 b.h.p. at 4,700 r.p.m. This gives a specific power of 49·5 b.h.p/litre for a piston loading of 3·65 b.h.p/in^2. This somewhat high value is consequent on the, by current standards, high stroke : bore ratio. The maximum torque is 167 lb-ft with b.m.e.p. 157 lb/in^2 at 2,500 r.p.m. The torque ratio is 1·13 : 1, with a speed ratio of 1·88 : 1, and the maximum piston speed 3,410 ft/min. Valve to cylinder bore ratios for inlet and exhaust are 0·46 : 1 and 0·40 : 1 respectively, while lift to throat diameter ratios are 0·28 : 1 and 0·32 : 1.

The considerable increase in both gas and inertia loading on the main and big end bearings has been catered for by fitting lead bronze bearings. These should have a satisfactory life since the crankpins and main journals are nitride hardened. The bearings are protected from abrasive wear by a large full-flow oil filter which also acts as an oil cooler, so further protecting the bearings from corrosion attack due to high oil temperature.

A light alloy cylinder head is used with valve seat inserts. In order to equalize temperatures throughout the length of the head as far as possible, a three-port off-take water manifold is fitted. To increase endurance and valve life, the inlet valve is in silicon-chromium steel and the exhaust in K.E.965. There are three piston rings, the top a Dykes pressure-controlled ring to obviate flutter at high speed, the intermediate a plain section and the third a slotted oil control ring.

Jaguar

Another illustration of progressive development over a period is provided by the Jaguar type D engine. On this the most fundamental change has been the adoption of dry sump lubrication to enable the overall height of the engine to be reduced and to allow installation lower in the chassis.

This is a 3·442 litre engine of 3·268 in bore by 4·173 in stroke, with a stroke : bore ratio of 1·28 : 1. It now operates with a 9 : 1 compression ratio and provides a maximum power of 250 b.h.p. at 6.000 r.p.m., with maximum torque and b.m.e.p. of 242 lb-ft and 174 lb/in^2 at 4,000 r.p.m. These figures represent a specific power of 73 b.h.p/litre with piston loading of 4·95 b.h.p/in^2. The torque ratio is 1·1 : 1 with a speed ratio of 1·5 : 1, and the maximum piston speed is 4,180 ft/min.

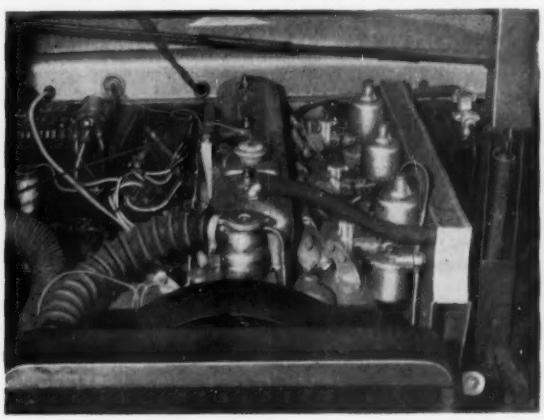
Mercedes Benz

It is not without interest to compare the 300 SL type Mercedes with the D type Jaguar. Both engines have been designed to provide the best possible sports car performance, but whereas the Jaguar uses multi-carburettors, the Mercedes is equipped for petrol injection. The Mercedes is a 6-cylinder 2·996 litres unit with bore and stroke of 3·35 in × 3·46 in (85 × 88 mm). Thus the stroke : bore ratio is 1·03 : 1. With a compression ratio of 8·55 : 1, the quoted net maximum power is 240 b.h.p. at 6,100 r.p.m. This, with allowance for the low installation losses likely in this car, should represent a gross power of about 260 b.h.p. The maximum torque is 217 lb-ft, representing 178 lb/in^2 b.m.e.p. at 4,800 r.p.m., both being net values. The corresponding specific power and piston load figures are 87 b.h.p/litre and 4·9 b.h.p/in^2.

The speed ratio is 1·27:1, and the influence of reduction in induction restriction consequent on the elimination of the carburettor is clearly shown by the very low value of 1·05:1 for the torque ratio. This implies a much flatter torque curve above maximum torque speed than is normal with a carburetted engine. The valve timing is not extreme, as can be seen by the figures of 11-53-37-11, giving an overlap of 22 deg. Maximum piston speed is 3,740 ft/min.

When comparing the Jaguar and the Mercedes, the influence of the stroke: bore ratio is apparent both in the piston speed, 4,180 for the Jaguar and 3,470 for the Mercedes, and in the specific power and piston loading. Both have approximately the same piston load of 4·9 b.h.p/in^2, but the Jaguar shows 73 against the Mercedes 87 b.h.p/litre, the stroke:bore ratios being 1·28 on the former and 1·03:1 in the latter.

In some respects the cylinder head layout and the combustion chamber location and form of the 300 SL are reminiscent of practice employed for some years by Rover. The cylinder head face joint is inclined to the cylinder bore axis and is flush. The two valves, while mounted parallel, are perpendicular to the joint face but are staggered in plan. On one side of the centre line, the piston crown is inclined to the bore axis at the same angle as the head joint, and, as the inlet valve is mounted immediately over it, forms a large cool quench area.



The engine installation in the Jensen 541

On the Porsche, two coils are employed

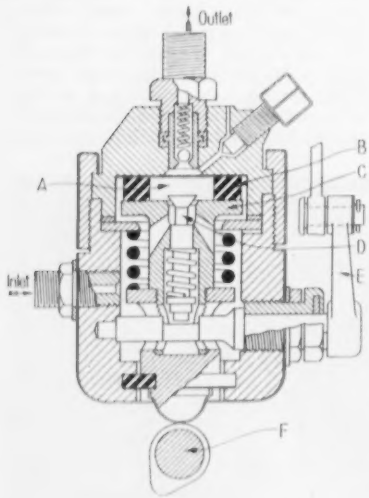
The other half of the piston crown is formed as a pocket. When the piston is at the top of its stroke, the piston pocket and a corresponding pocket in the top of the cylinder wall form a chamber that is approximately hemispherical, concave up. Located in the head is the inclined sparking plug with the points on the longitudinal centre line of the chamber. The fuel injector nozzle projects through the cylinder walls into the chamber.

Finger type rockers carried on a common fulcrum shaft at one side of the rocker box, operate the valves, which have normal type helical springs. A single overhead camshaft operates on top of the rockers. The engine is canted to an appreciable angle in the chassis to reduce the overall height, a point on which the adoption of dry sump lubrication also helps. Long air inlet pipes lead across the inclined crankcase outer wall to the individual outlet ports from a common large bore manifold pipe fed from the front of the car. A diesel type injection pump of Bosch manufacture is driven from the front of the engine where the duplex roller chain drive to the overhead camshaft is also located.

Rover

Although not new, the three Rover engines constitute a further series of engines. Only a limited degree of standardization has been effected, since neither the bore nor the stroke is common throughout the series. Of the three, designated the 60, 75 and 90, the 75 has been so extensively modified for this year as almost to constitute a complete redesign.

The engines, of 1·997, 2·230 and 2·638 litres capacity, have cylinder dimensions of 3·06 × 4·14, 2·84 × 3·50 and 2·84 × 4·14 in, the smallest being a four and the remaining two six-cylinder units. Thus the stroke is the same on the 60 and the 90, and the bore the same on the two six-cylinder engines. This arrangement leads to a variety of stroke:bore ratios in the order 1·35, 1·22 and 1·44:1, while the corresponding compression ratios are 6·7, 6·75 and 6·73:1. With this number of variables, it is noteworthy that the same value of maximum b.m.e.p., 125 lb/in², is obtained in each engine, although at the speeds of 2,000, 1,750 and 1,500 r.p.m. The maximum powers are 60, 80 and 90 b.h.p. at 4,000, 4,500 and 4,500 r.p.m. respectively. A new departure this year is that all three engines have a single horizontal S.U. carburettor which feeds through a water jacketed manifold.



A—Pressure chamber
B—Synthetic rubber washer
C—Plunger
D—Fuel inlet valve
E—Control valve
F—Actuating cam

A & A injection pump

Kieft

Two sports engines designed for high output are worthy of examination. Both are offered for installation in Kieft cars. The first is the Coventry Climax, a four-cylinder engine of 1·098 litres capacity, of 2·85 in bore and 2·625 in stroke. The engine is thus "over square" with a stroke:bore ratio of 0·93:1. At a compression ratio of 8·8:1 the maximum power is 72 b.h.p. at 6,200 r.p.m. at which the piston speed is 2,700 ft/min. Specific power figures of 65·7 b.h.p/litre and 2·82 b.h.p/in² piston area are obtained, the latter being quite moderate. The maximum torque of 64 lb-ft is developed at 5,000 r.p.m., at which the b.m.e.p. is 144 lb/in², for a torque ratio of 1·04:1 at a speed ratio of 1·24:1.

A single overhead camshaft operates parallel inclined valves in wedge-shaped combustion chambers. An unusual drive is employed for the camshaft. In this arrangement an intermediate shaft, parallel to, and gear driven from, the crankshaft, is coupled to the camshaft by a duplex chain, the tension of which is maintained by an automatic tensioner. The intermediate shaft also provides the drive for the oil pump and distributor by normal skew gears. A "hunting tooth" is introduced in the timing drive. The main journals are 2·125 in diameter and the crankpins 1·75 in, so that the overlap represents 29 per cent of the main journal diameter, which even for a three-bearing shaft indicates a rigid unit. The main and big end bearings are steel backed lead bronze.

The second engine, as yet in an early stage of development, is a flat four with air cooling. It is based on proprietary units and has chain-driven twin overhead camshafts. There are independent cylinder barrels and heads for each bank. The heads carry particularly deep finning and are fitted with a central plug. Hairpin valve springs are used. Springs of this type are not infrequently employed on air-cooled engines because they can be arranged so as to be in the flow of cooling air and therefore do not overheat and lose temper. In addition, they tend to have a higher surge frequency than coil springs.

Borgward

Another engine providing points of interest is the Borgward, installed in the new Isabella model car. It is an O.H.V. four-cylinder water-cooled engine of 1·493 litres capacity; the bore is 2·95 in and stroke 3·33 in, for a stroke:bore ratio of 1·12:1. The compression ratio is 6·8:1. Maximum power of 60 b.h.p. is developed at 4,700 r.p.m., at which the piston speed is 2,610 ft/min.

An interesting feature is the manner in which the induction manifold is cast integral with and is entirely closed within the rocker cover. For easy adjustment of the push-rod operated valve rocker clearance, the ends of the rockers with the adjuster screws project through openings in the inclined side of the rocker cover. A removable cover plate is fitted and a similar one on the opposite side of the rocker cover gives access to the valve stems for insertion of the feeler gauge. A practical feature from the servicing aspect is the location of the oil filter. It is mounted high at the rear of the engine and, being a centre bolt unit, is most accessible.

D.K.W.

A three-cylinder two-stroke engine of 0·896 litre capacity is the power unit for the D.K.W. The bore is 2·79 in and the stroke 2·99 in, giving a stroke:bore ratio of 1·07:1. With a compression ratio of 6·5:1, the engine develops a maximum power of 34 b.h.p. at 4,000 r.p.m., at which the piston speed is 2,000 ft/min. The specific power is 37·9 b.h.p/litre with piston loading of 1·86 b.h.p/in².

On this unit the radiator is behind the engine, and the arrangement for driving the fan is interesting. From a pulley on the nose of the crankshaft, the drive is taken to an overhead shaft running the length of the engine and supported in a tunnel formed in the cylinder head. The fan is mounted on the rear end of this shaft. This system is also employed on the Fiat 500. Both installations have large area heat shields over the exhaust manifolds to prevent heated air from being passed through the radiator matrix.

Diesel

There is still little evidence of appreciable interest in the application of the diesel engine to private cars. Borgward showed an engine and Mercedes offer a diesel unit in their 1800 model; the only newcomer in this field is Standard. As an alternative to the 2·088 litre Vanguard engine, Standard Motor Co. Ltd. offer a diesel unit of 2,092 cm³ capacity which develops 40 b.h.p. at 3,000 r.p.m., the maximum torque being 85 lb-ft at 1,500 r.p.m. with a b.m.e.p. of 100 lb/in². The piston speed at maximum power is 2,000 ft/min. Comparable figures for the petrol engine are 68 b.h.p. at 4,200 r.p.m. with 108 lb-ft maximum torque at 2,000 r.p.m., the

equivalent b.m.e.p. being 128 lb/in². The compression ratios are 17 and 7:1 respectively.

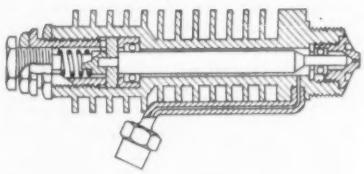
Petrol injection

The advantages to be gained by the adoption of petrol injection in place of carburation are widely recognized, the principal ones being:—

1. Higher power owing to the higher volumetric efficiency made possible by the elimination of the choke tube.
2. Lower fuel consumption due to the improved distribution.
3. Lower fuel consumption when using direct cylinder injection by employing a non-homogeneous charge with a lower average mixture strength.

However, the high cost of the equipment has retarded the application of the system to private cars. Because the designs of injection pump hitherto available necessitate an instrument standard of machining finish on the pumping elements, it has not been possible to compete with the carburettor on an economic basis. Now, Automobile and Aircraft Services Ltd. of Kenton, Middlesex, have developed an injection pump and nozzle which, it would appear, can be produced at appreciably lower cost.

The pump design eliminates the need for the extreme accuracy and the very fine tolerances required in the orthodox pump. Briefly, it consists of a piston operating in a cylinder housing from which it is supported by a flexible diaphragm. Trapped between the piston head and the underside of a pressure chamber into which the piston projects, is a ring of plastics material. An orthodox delivery valve is located in the top of the pressure chamber and a spring loaded poppet type of inlet valve is located in the centre of the piston head. The timing for the closing of this valve during the delivery stroke can be varied by operation of an external linkage. A cam and return spring control the piston in the orthodox manner. On the return stroke, petrol passes through the inlet valve to the pumping chamber, and as the



A & A injection nozzle

piston rises under the cam lift, the chamber volume is reduced by the combined action of the piston and by the inward distortion of the trapped plastics ring.

With this construction, sealing of the pressure chamber does not rely on the fit of working surfaces. Provided it can be established that the sealing rings can be produced in quantity to sufficiently close tolerances on a functional specification and that these can be held stable under operating conditions, the pump is a most attractive design as it tends to economical production methods. The limited test results available to date concerning a 250 cm³, single cylinder, two-stroke engine are encouraging. Even so, some problems with regard to metering and control may still remain to be solved before this unit is satisfactory for general applications.

Oil filter

To satisfy the contentions of the two schools of thought on oil filters, one supporting the full flow and the other the by-pass, it has been felt for some time that the ideal system would be one embodying both types. Hitherto, considerations of space required for their installation and of cost have precluded their adoption. Now these objections appear to have been overcome by a new filter, known as the Micro-Jewel, which was shown by The Parr Equipment Co. Ltd. of Kensington. Outwardly there is no departure from normal filter design but the element is formed with two concentric fitting surfaces, pleated to increase the area. The oil being fed to the main gallery of the engine is filtered by passage through one of the surfaces, while a portion of the oil feed is bled off through the second surface to provide by-pass filtration and is returned to the engine sump.

Should the elements become choked through lack of servicing, relief against excessive pressure build up is provided by spring loading the cartridge element and allowing it to lift. Standard cartridges are used, the number employed in any filter being determined by the flow capacity required. When more than one is used, the cartridges are fitted end to end.

CARBURETTORS AND INDUCTION SYSTEMS

Wider Use of Thermostatically Controlled Hot-spot, and Improvements in Air Cleaning and Petrol Filtration

DURING the years immediately before and just after the last war, there was a tendency among some British engine designers to follow the American fashion in specifying carburettors with automatic chokes. From a study of the exhibits at the Motor Show, however, it seems that the automatic system has to some extent lost popularity in this country, for there were certainly fewer British-made engines so equipped. In America, however, the automatic choke is still almost universally employed. So far as could be ascertained on the stands, the only American cars fitted with hand strangler systems are Chevrolet, Willys and Ford. Most of the models of the other manufacturers are equipped with versions of the hot-air type of thermostatic control, in which the bi-metal thermostat spring is housed in a small chamber on the side of the carburettor.

In most of these systems the bi-metal spring is linked to the strangler valve spindle in such a manner as to close the valve when the engine is cold. When the engine has been started up, hot air from a *stove* on the exhaust manifold is drawn by manifold depression through tubes and channels, over the thermostat spring, which then loses tension and opens the strangler progressively as the engine warms up. All versions of the system incorporate an automatic fast-idle mechanism.

Although the return to hand stranglers on British cars may at first sight appear to be a retrograde step, there is good reason for it. Nevertheless, it is surprising that the automatic choke with a manual over-ride has not been exploited, since this arrangement incorporates the best of both systems. In this country, it is not unusual for a car owner to drive only three or four miles to and from business each day. Under these conditions, a hand choke is preferable, providing it is used intelligently. However, in America journeys of longer duration are more common; moreover, there is a marked trend in that country towards completely automatic controls for all purposes.

As in previous years, the great majority of carburettors employed are of the open-choke pattern, and in the American and Continental cars all are of this design. Most are of the down-draught type, despite the trend towards lower bonnet-lines. America has led the way in the design of very short downdraught carburettors, and this will doubtless set the fashion. A number of models, including those of the Nuffield Organization, employ the S.U. constant-vacuum carburettor, either in the horizontal or semi-down-draught form. For the latter form, the standard horizontal carburettor is used, but it is tilted slightly downward at the outlet, with the float chamber kept in the vertical position. Almost all downdraught, open-choke carburettors with throttle bores larger than 30 mm incorporate automatic economizer and accelerator pump systems. Where the hand strangler

device is used, it is invariably linked with an automatic fast-idle system for warm-up.

The American four-barrel, open-choke, downdraught carburettor, introduced two years ago on several of their higher powered V8 engines, continues to be standard equipment on a number of models. Some manufacturers, however, still employ the conventional twin-barrel instrument, possibly on account of its relative simplicity. The four-barrel carburettor is in effect two twin-barrel units side by side, but with a common float chamber. In each twin unit the throttle valves are carried on a spindle at right angles to the engine crankshaft. One pair of barrels, known as the primary carburettor, operates over the cruising range, while the other pair, the secondary carburettor, is brought into action for full power at wide throttle openings at higher engine speeds.

Change-over is effected by a second pair of valve plates fitted under the normal throttle valves of the secondary carburettor. These valve plates are offset-mounted on their spindle, which, on the end, has a weighted lever that holds them closed. Thus, even though the main throttles of the secondary carburettor are open, it will not come into action until the pressure differential on the valve plates is sufficient to open them against the weight on the lever. The main throttle valves of both sections of the carburettor are linked together in such a manner that in any case the primary carburettor comes into action first. This arrangement is ingenious but somewhat complicated and may not be ideal from the servicing point of view.

Pumps for the transfer of fuel from the tank to the carburettor continue to be mainly of the mechanically operated diaphragm type. They are bolted to the side of the engine crankcase and are generally directly actuated by an eccentric on the engine camshaft. This system is universal on the American cars that were exhibited. The majority of British and Continental engines are similarly equipped, but some British cars are fitted with the S.U., electrically operated fuel pump. There is evidence that the position of the mechanical fuel pump on the engine crankcase is not all that might be desired. This is apparent from the various methods employed to keep the pump cool. In most instances, a reinforced asbestos sheet is used to protect the pump from heat radiated from the exhaust system.

Increasing fuel volatility will tend to aggravate vaporization troubles, and no doubt most engine manufacturers are alive to this possibility. In certain installations, however, no attempt has been made to protect the fuel pump and the carburettor from radiated and conducted heat. In these circumstances, vaporization troubles would seem to be unavoidable, but possibly there is greater need to guard against carburettor icing. In this country, there is an increasing tendency to use reinforced asbestos shields between downdraught carburettors and the manifolds below, but on Continental cars, shields of sheet metal are more frequently employed.

There is a marked trend towards the use of petrol filters. They are extremely useful, but liable to provoke vapour troubles unless suitably placed and protected from heat. Air filters and air silencers are now standard equipment on most cars, and several types are available. In some cases a silencer only is employed, but in others a combined silencer and oil bath air filter is fitted. Another arrangement is a combination of the two installed in series; that is, an air silencer fitted to the carburettor, with an oil bath air filter attached to the air entry end of the silencer.

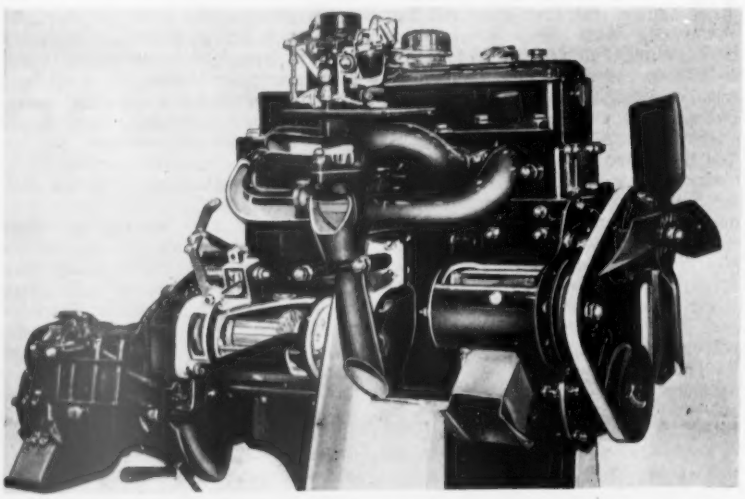
The Americans show great ingenuity in designing short oil bath air cleaners which surround the downdraught carburettor, thus reducing the overall height of the carburettor and air cleaner assembly. A good example of this layout is the Mercury Thunderbird. The quick-release form of air silencer fixing, widely used on American cars, might well be employed to a greater extent in this country. Another development that might be followed is the total enclosure of the carburettor, inside the air cleaner, as exemplified by B.M.W.

Induction system arrangements show wide divergencies of opinion among designers. Some are simple, others are complex. During the last few years, there has been a marked increase in the popularity of the thermostatically controlled hot-spot. This was first used in this country by Vauxhall Motors Ltd. shortly before the war. More recently, a number of British designers have followed suit, and the latest converts are the new Humber Hawk Mark VI and the Sunbeam Mark III. Last year, a thermostatically controlled hot-spot was introduced on the Hillman Minx and Ford Prefect, while the arrangement was first adopted on the Standard Vanguard in 1951.

In all variants of the scheme, a stainless steel flap is mounted in the exhaust manifold under the junction of the riser and gallery tract. This flap is offset on its pivot, the ends of which protrude through the casting. To one end is attached the centre of a coiled bi-metal thermostat spring, the other end of which is fixed to a pin on the manifold casting. Before the engine is started, the flap valve is held, by the thermostat spring, in the "cold" position in which it directs the exhaust gases through a jacket surrounding the junction of the riser and gallery of the induction tract. As the thermostat warms up, it releases the valve, which moves to the "hot" position. The exhaust gases are then deflected away from the induction manifold and directly into the exhaust down-pipe. When the valve is in the "hot" position, a bob-weight on the end of the spindle remote from the thermostat spring rests against a stop so that the spindle assembly does not rattle.

Rootes Group

Introduced earlier in the year, the latest Humber Hawk model is equipped with an entirely new four-cylinder, engine of 2,267 cm³ swept volume. It has overhead valves instead of side valves, as in the earlier engine. The carburation system, of course, is also quite different, the induction system now being of the four port, rake type, instead of the earlier two port unit with siamesed inlet ports. Both manifolds are now on the right-hand side of the engine and are of cast iron. The downdraught carburettor evidently has been designed against a background of cold starting tests at low temperatures. It is mounted on an induction gallery tract that rises sharply on each side of the junction of the riser and gallery. At this



On the Renault 2 litre engine, an exceptionally robust heat shield is fitted between the carburettor flange and the manifold

junction there is a small well in the floor of the tract, from which the drain tube is taken. Following the usual Rootes Group practice, the drain tube is fitted with a non-return ball valve at its base. This gives a large area drain orifice, which closes when the engine is idling and running at small throttle openings.

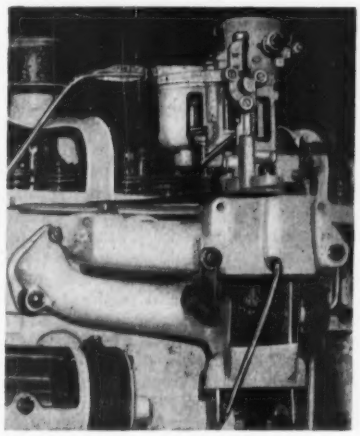
From each inclined gallery tract, the two inlet branches slope gently upwards to join the separate ports in the cylinder head. For the most part, the cross section of the branches is circular, but that of the gallery tracts is semi-circular. Surrounding the junction of the riser and gallery is a jacket, through which, during the warm-up period, hot exhaust gases are passed from the heat control valve below. Locating sleeves are fitted in the two intermediate ports to ensure proper alignment of the passages. This is a noteworthy feature.

Directly beneath the induction system is the four port exhaust manifold. Its off-take to the down-pipe is in the centre, below the riser junction. The stainless steel flap of the thermostatically controlled heat valve is mounted on a spindle that is parallel with the crankshaft and extends through the exhaust manifold casting. On the rear end of the spindle, the bi-metal, coiled thermostat spring is fitted. This spring is housed in a light, pressed steel cover to protect it from cool air currents. A weight is attached to the front end of the spindle to stop the flap valve and spindle from rattling. Following conventional practice, the flap valve is mounted eccentrically on the spindle, the larger area being below the axis.

The carburettor is the latest Zenith-Stromberg DI-36 unit. This is a double venturi, downdraught instrument, complete with accelerator pump and economizer system. To eliminate undesirable movement of the float, and consequent flooding, when the carburettor is on flexibly mounted engines, a weight is mounted above the centre of the float lever pivot. A re-designed strangler and fast idle system provides for a sufficiently wide throttle opening for cold starting at temperatures as low as zero deg F, as well as progressive reduction of the throttle opening as the strangler is released.

Air filtration is by means of a large, AC oil bath silencer and cleaner, attached to the side of the chassis. At the top of the silencer, a length of corrugated rubber hose sweeps from the front, back to the racquet-shaped air intake elbow-piece fitted to the top of the carburettor. Crankcase ventilation is effected by a tube leading from the top of the rocker cover into the intake elbow-piece. A reinforced asbestos shield is fitted between the carburettor and induction manifold flange, and extends forwards underneath the carburettor float chamber. This assists in keeping the carburettor cool in hot weather. Further protection is afforded by a thick, heat insulator between the carburettor and induction flanges. As in all the Rootes Group models, an AC pump of the mechanical type supplies the fuel. On this model it is mounted on the left-hand side of the engine, and is therefore remote from the exhaust manifolds.

A model that has been awaited with considerable interest is the Hillman Minx Mark VIII. This vehicle is equipped with a new overhead valve power unit of 1,390 cm³ swept volume. The induction system is somewhat similar to that of the new overhead valve, Hawk engine. On the left-hand side is a Zenith 30-VI downdraught carburettor. It supplies mixture to the four port branch induction system. The cast iron induction manifold is above that of the exhaust. Separate castings are employed for each. The junction between the riser and gallery is jacketed for exhaust heating. A heat control valve with a thermostat spring of the conventional type is incorporated.



A thermostatically controlled heat valve is employed on the overhead valve engine for the Hillman Minx

In shape, the induction tract is of the straight rake pattern, the main gallery being tilted up a little at each end. The gallery is of semi-circular section, but the four port branches are circular and rise slightly to meet the cylinder block. Locating sleeves are carried in the abutting ends of the manifold and cylinder head ports. As in all Rootes Group models, a manifold drain tube is taken from the bottom of the riser T-junction, but the usual non-return valve is not incorporated. As on the Humber Hawk and Sunbeam Talbot models, the carburettor is protected from radiated heat by an asbestos shield and an insulator under the carburettor flange. Special attention has been given to the cold start and drive-away conditions, and the interconnected strangler and fast idle system has been specially designed to provide the most satisfactory strangler opening and engine speed over the warm-up period.

The new Hillman Husky is powered by a side valve engine, similar to that of the previous model of the Hillman Minx. A Zenith 30-VM-7 downdraught carburettor is employed. This is a simple carburettor with no accelerator pump or economizer, but equipped with offset strangler valve and fast idle linkage for cold starting. The induction and exhaust manifolds are separate castings on the right-hand side of the engine. A two port branch pattern has been adopted for the induction system. It serves siamesed ports in the cylinder block. The riser junction is jacketed for exhaust heating and a thermostatically controlled heat valve is in the body of the exhaust manifold below. This form of mixture heating was introduced on the side valve Hillman Minx for the first time last year. The induction gallery is of rectangular cross section and the tracts curve in without abrupt bends towards the cylinder block. As on the previous side valve model, the mechanical fuel pump is on the right-hand side of the crankcase, and a T-type air silencer, strongly stayed to the cylinder head at each end, surmounts the carburettor.

Also a newcomer, and a product of the Rootes Group, is the Sunbeam Mark III. This engine is basically similar to that of the Hawk model described above and has the same bore and stroke, but is designed to deliver an extra 10 b.h.p. Whereas with the Hawk engine the manifold is of the four port branch, rake pattern, the Sunbeam, which also has four ports, is a development of the previous Sunbeam Talbot system.

On the Mark III, the induction manifold casting is of aluminium and is mounted above the cast iron exhaust. The induction tract is a combination of the twin-gallery and the four port branch designs; but whereas on the earlier model the four branches started to divide into pairs close to and on each side of the riser, in the new engine they divide on each side at a point some 4 in from the axis of the riser. From the point of separation, the branches rise slightly to the ports in the cylinder head. The tracts at the riser junction are rectangular in section, but gradually merge into circular form as they curve in towards the block. Sleeves are fitted to ensure true location.

As on the new Hawk engine, the junction of the riser and gallery is jacketed for exhaust gas heating, and a thermostatically controlled heat valve is incorporated in the exhaust manifold casting below. Here again, the carburettor is the new Zenith-Stromberg DI-36 downdraught unit. On top of it is fitted an air intake elbow of similar design. From this elbow, a long length of corrugated rubber pipe is taken over the top of the engine to the large, oil bath air cleaner, which is attached to the left-hand side of the engine compartment. Fuel supply is by mechanical pump, again on the left-hand side and remote

from manifold heat. A reinforced asbestos heat shield is fitted in addition to the thick heat insulator between the carburettor and manifold flanges.

The induction system of the Humber Super Snipe is of the six port branch design, with the inlet valves of cylinders 2 and 3, and 5 and 6 next to one another; thus, the port branches that serve these valves are close together at each end of the manifold. The exhaust ports of cylinders 3 and 4 adjoin one another, so the induction port branches of cylinders 3 and 4 are each flanked by exhaust ports.

From the exceptionally short riser of the semi-circular section, cast aluminium induction manifold, the two arms of the gallery slope upwards so that surplus fuel drains into the well under the riser. A drain tube, with a non-return ball valve in its base, is taken from the well. Since the engine is inclined in the longitudinal plane at an angle of some 5 deg in the chassis, the slope of the rear arm of the gallery is greater, relative to the cylinder head ports, than that of the front one. Therefore, the two rear port branches leave the gallery close to the floor level of the gallery tract, but the front pair leave at a higher level. This presents a rather out-of-balance appearance but the design is basically sound.

Both manifolds are on the left-hand side of the engine, with the six-port exhaust manifolds below. The two castings are bolted together beneath the riser, and a thin plate of stainless steel is fitted between the two open flanges. Carburation is by a new Zenith-Stromberg carburettor, the DIV-42 unit, which incorporates among other things, a new design of hand operated, semi-automatic strangler valve linked with a fast idle mechanism. A mechanical fuel pump is mounted on the right-hand side of the engine, remote from the exhaust system. Both the pump and the petrol filter are protected by reinforced asbestos shields. Air filtration is effected by a large, cylindrical oil bath air cleaner fitted in a vertical position on the right-hand valance. A corrugated rubber hose connects it to the fabricated air intake elbow on the carburettor.

Lanchester and Daimler

A new model incorporating some novel features is the 1,622 cm^3 power unit of the Lanchester Sprite. It has a single downdraught carburettor, which supplies a four port branch induction system of the straight rake type. In this instance, the port branches are close together in pairs, each pair being almost at the extreme ends of the induction gallery tract. The tract is of circular cross section, and the branches leave the gallery at right angles to it and in the same plane. Below is the four port exhaust manifold. The two manifolds are connected to form a hot-spot immediately below the riser.

An interesting feature of the exhaust system is the arrangement of the porting. In order to obtain the maximum extractive effect of the exhaust gases, the manifold contains two separate tracts, which terminate in a single flange with two orifices. One tract is connected to the head exhaust ports of cylinders 1 and 4, and the other to the ports of cylinders 2 and 3. Two separate down-pipes are taken from the exhaust manifold flange, but join a short distance from the flange connection; the pipe then extends back to the single exhaust silencer beneath the floor behind the driver's seat.

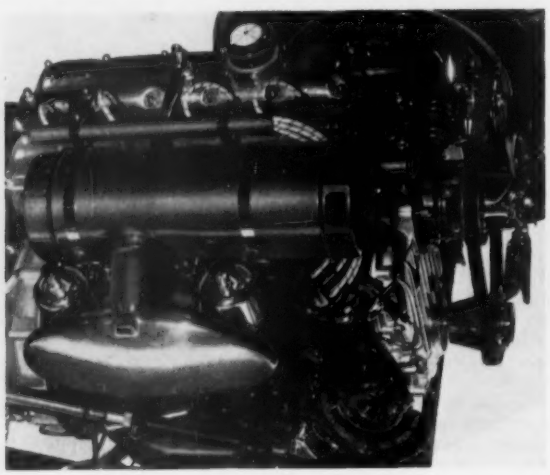
The carburettor, a Zenith 36 VIS downdraught unit, is of the economizer type, with an accelerator pump, strangler valve and fast idle linkage for cold starting. An asbestos heat shield is placed between the carburettor and the manifold. Fuel supply is by an AC mechanical pump, fitted to the left-hand side. An L-type air silencer is mounted transversely above the engine. A breather pipe is fitted between the rocker cover and the carburettor end of the air silencer.

External induction systems of the six port branch design are not widely used now on six-cylinder engines. The Daimler Co. Ltd. has, however, employed this arrangement on their six-cylinder engines for a number of years; and the two engines, of 3,468 cm^3 and 4,617 cm^3, which are alternative power units of the new Regency model, are not exceptions. On both, the induction and exhaust manifolds are on the right-hand side of the engine, the induction being uppermost. However, the two manifolds do not touch, but heat is supplied to the induction system by hot coolant passed through jackets cored almost the whole length of the induction manifold casting. Two S.U. horizontal carburettors supply the main induction gallery tract, which is straight and extends nearly the whole length of the engine.

The cast aluminium induction manifold is of the classic straight rake pattern, the port branches being arranged in pairs. Each branch feeds an inlet valve port. Thus, each carburettor supplies three cylinders, the spacing between them being such that the front carburettor is in the wide gap between port branches 2 and 3, and the rear carburettor between numbers 4 and 5. Port branches 1 and 2, and 5 and 6, are close together and feed adjacent inlet valves. The main induction gallery is of circular cross section. From it, the six port branches slope down towards the cylinder head.

A single, AC T-type air silencer is mounted along the top of the rocker cover, and an inverted Y-shaped air intake casting connects it with the intakes of the two carburettors. Although twin exhaust manifolds are employed, the two down-pipes meet a short distance from the engine and a single silencer is employed. Following the latest trends, the fuel tank is mounted behind the rear seat squab, and fuel is supplied to the carburettors by a mechanical pump on the left-

A conventional four-port rake type induction system is incorporated on the Lanchester Sprite



On the 2½ litre engine of the Riley Pathfinder, the twin, S.U. horizontal carburation system is retained

hand side of the engine. It is actuated in the usual manner by an eccentric on the camshaft.

British Motors Corporation

On the B.M.C. 1,489 cm³ engine in the new Morris Oxford, a conventional form of two port branch induction system is employed. It is served by an inclined, or semi-downdraught, S.U. carburettor. On the left-hand side of the engine, the induction and exhaust manifold castings are separate units bolted together at the riser junction to form a hot spot. The galleries turn in towards the cylinder head ports in fairly sharp curves, and the cross section is circular throughout. Air filtration is by means of a large, A.C. unit of cylindrical form. This unit is installed high up towards the rear of the engine compartment. To accommodate this layout, a cast aluminium air intake connection of unusual shape connects the intake of the carburettor with the base of the air cleaner. A crankcase ventilation tube is taken from the rocker cover to the top of the air cleaner. To reduce transfer of heat from the manifolds to the carburettor, a thick heat insulator is fitted between the manifold and carburettor flanges. As in all the Morris products, the fuel supply from tank to carburettor is by an S.U. electric pump.

An unusual feature of the system is the method of attaching the exhaust manifold to the down-pipe. The off-take for the exhaust manifold is just behind the junction of the rear port branch and the gallery. Instead of the conventional three or four bolt flange, the off-take walls are slotted and the down-pipe fits into it. Two clamping pieces are bolted round the off-take casting and tighten the slotted portion round the down-pipe to effect a seal.

A similar arrangement has been adopted on the new Morris Cowley, which has a B.M.C. engine of 1,200 cm³. Here again, a two port branch induction manifold, feeding a pair of siamesed inlet ports, is bolted to the exhaust manifold at the hot spot. The carburettor is an S.U. semi-downdraught unit and is fitted with an oil bath air cleaner. As in the Oxford, petrol is supplied to the carburettor by an S.U. electric fuel pump. The float chamber assembly is stayed by a pressed steel bracket to the main body of the carburettor.

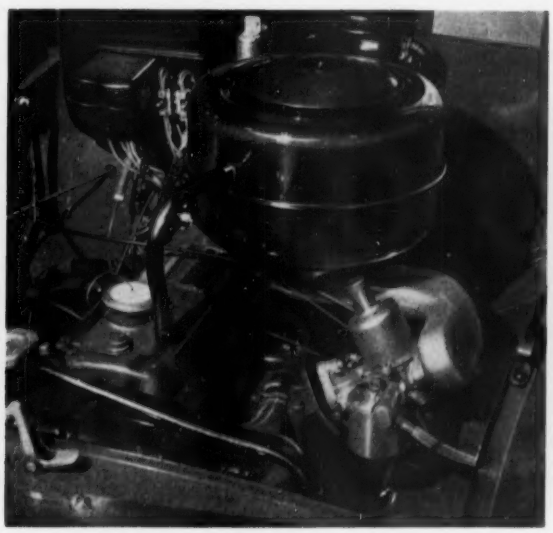
Alternative power units, 1,200 cm³ or 1,500 cm³, are offered for the Austin Cambridge. They are B.M.C. units, and are virtually the same basic engine as in the Morris models. For both, the fuel system is the same, and the aluminium induction and cast iron exhaust manifolds are on the left-hand side on each engine. The two galleries of the two port branch induction manifold are of circular cross section. They slope upwards slightly as they leave the riser T-junction and turn sharply inwards with small radius bends to the cylinder head ports. Immediately under the riser, the induction and exhaust manifolds are bolted together, and a hot-spot plate of stainless steel is clamped between them. The bolt flanges of both manifolds are open to allow the exhaust gases to play directly on the underside of the plate, so that any wet fuel that falls on the upper side is quickly vaporized.

Mixture is supplied by a Zenith 30-VIG downdraught carburettor, which incorporates an economy system, for economical part-throttle running, together with an accelerator pump. Cold starting is by means of a semi-automatic strangler valve, with an interconnected fast idle system. A drain tube of small bore is taken from the induction tract at a point just to the rear of the riser junction, but a non-return ball valve is not incorporated. To prevent liquid fuel from running down into the suction advance, diaphragm chamber, the take-off union on the carburettor is taken from a point higher than the actual suction advance orifice adjacent to the throttle edge, a channel being cored for this purpose.

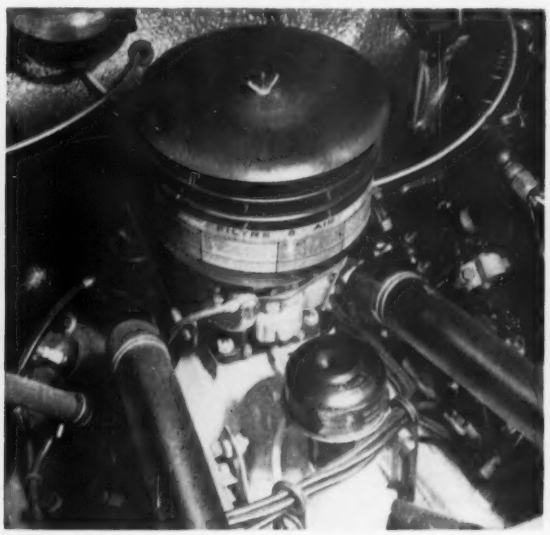
The fuel tank arrangement is unusual in that it is high up in the boot, so there is a slight gravity head at the mechanical fuel pump. This pump is near the front on the left-hand side of the engine crankcase. A small tap is provided where the suction pipe from the tank joins the fuel pump; it can be turned off to prevent loss of fuel if the fuel pipe connections are loosened during servicing operations. Air filtration is by means of a small, circular oil bath air cleaner fitted directly on top of the carburettor. The connection between the exhaust manifold and the down pipe is similar to that of the Morris Oxford.

On the new 2,639 cm³ power unit of the Austin Westminster, the carburation system is a complete break-away from previous Austin practice. The induction system is of the long internal gallery pattern, strongly reminiscent of some earlier Weslake schemes. Such a design was employed on the Armstrong Siddeley 16 h.p. and 18 h.p. engines, production of which has only recently been discontinued. The existing Armstrong Siddeley Sapphire also incorporates an internal gallery with individual inlet valve ports, but in the Austin, the external induction manifold is of the two instead of the four port branch type.

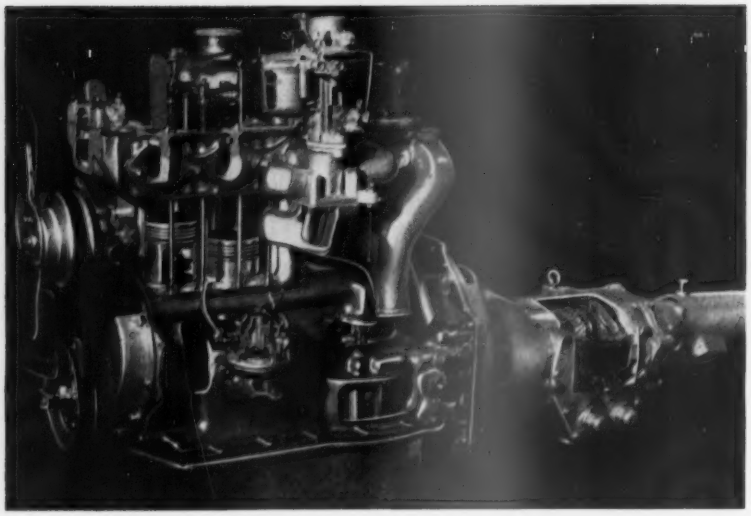
The induction and exhaust manifolds are on the left-hand side. A Zenith 42-VIS downdraught carburettor feeds a two port branch manifold of cast aluminium. The track is of circular cross section and slopes up on each side of the riser T-junction and levels out as it curves inwards to the



The S.U., semi-downdraught carburettor and two port induction manifold on the B.M.C. engine as installed in the Morris Oxford



In the Aquilon engine for the Vedette 55, a conventional cross over pattern induction manifold is employed in conjunction with a dual downdraught carburettor



In this version of the B.M.C. four-cylinder engine, a Zenith downdraught carburettor is used in conjunction with a two port induction tract and a thin-plate hot spot

cylinder head ports. A long straight passage, also circular in cross section, is cored in the angle between the top and left-hand side of the cylinder head to form the main gallery tract. From this tract, the six port ducts drop steeply to their inlet valves, so that the mixture is drawn up the slope of the external manifold tract to the main gallery, then falls to each valve. The main gallery is partitioned in the middle, the partition carrying a balance orifice of some ½ in diameter.

There are two separate, three port branch exhaust manifolds, each leading down to an off-take flange positioned slightly to the rear of the centre of the engine. The eccentric arrangement has been adopted because the front manifold is a little longer than the rear one, the extension being used to provide a hot-spot for the induction riser. A large flanged boss on the manifold casting rises to meet another on the induction casting. Both flanges are open, and a steel plate is bolted between them. Since the hot-spot plate is above the path of exhaust gas flow through the manifold, a large scoop casting is attached to its lower face to ensure that sufficient heat is transmitted to it. As an additional aid to evaporation of the fuel, a perforated metal plate is bolted above the hot-spot plate.

A manifold drain is taken from the floor of the tee, the drain pipe being led away from under the induction flange. Fuel supply to the carburettor, which is of the economizer and accelerator pump type, is by means of an A.C. mechanical fuel pump. This pump is on the right-hand side of the engine, and is thus remote from radiated heat from the exhaust system. An oil bath air filter is employed, with a racquet-shaped air intake. The small end of the intake fits over the carburettor entry. Although twin exhaust manifolds are used, the down-pipes merge into one as they turn into the horizontal run to the exhaust silencer.

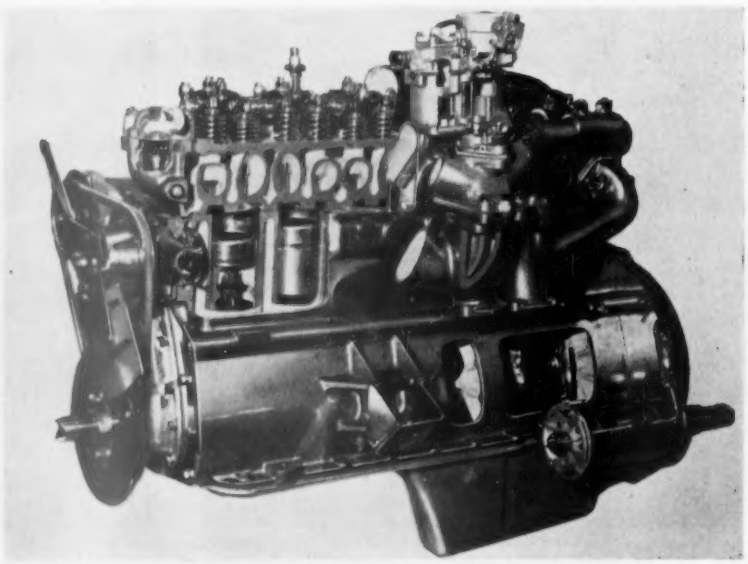
A similar version of this engine is fitted in the new Wolseley Six-Ninety, but the external manifold is not used. Instead, twin S.U. horizontal carburettors, together with distance pieces, are bolted direct to the flanges of the main induction gallery. A cylindrical air silencer is mounted longitudinally above the main induction gallery, a large inverted Y-shaped duct connecting it with the air intakes of the two carburettors. Here again, although twin exhaust manifolds are fitted, these join a single silencer.

Armstrong Siddeley

Armstrong Siddeley Motors Ltd. exhibited two versions of the Sapphire, one with a single and the other with twin carburettors. The single carburettor model is unchanged so far as the induction system is concerned, the carburettor being a Zenith-Stromberg DAV-36, downdraught unit with a semi-automatic hand strangler and interconnected fast idle system. On the twin carburettor model, some detail changes have been made, one of which is the introduction of a torsionally rigid connection between the two Zenith-Stromberg DAA-36 downdraught carburettors, the distance between the throttle body centres being some 12 in. This new connection is manufactured by the Zenith Carburettor Co. Ltd. Attached to the inner protruding end of each throttle spindle is a universal joint of the steel disc type. These joints, in turn, are interconnected by a brass rod. This is a simple and effective arrangement, and a great improvement on the system of twin bell-crank levers and rods employed on the original version of the twin carburettor layout. There is a similar arrangement on the twin S.U. installation on the Bentley.

The Armstrong Siddeley induction system, of somewhat tortuous appearance, is retained; but appearances in this instance are evidently deceptive, for the power output is surprising. With twin downdraught carburettors of only 36 mm throttle bore, this 3,435 cm³ unit delivers 150 b.h.p., which doubtless is sufficient for this application. However, there must be a lot of power in hand, should further development be required later.

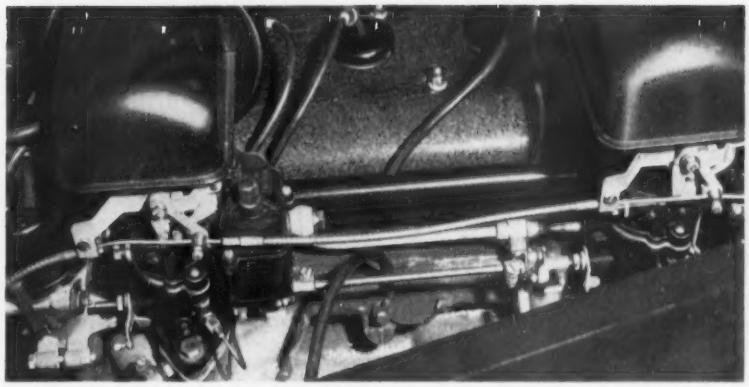
A six-port gallery tract is cored in the cylinder head. All the inlet ports leave the gallery at a slight angle to terminate at the inlet valve seat in each hemispherical cylinder head. It would be interesting to know what bearing, if any, the induction system design has upon the good reputation of these models so far as petrol economy is concerned. The gallery has a detachable partition at the



An internal induction gallery with an external two-port manifold is a feature of the new B.M.C. engine for the Austin Westminster

centre. A hole pierced in this partition forms the balance orifice. With the single carburettor installation, an external, four port branch induction manifold feeds the inner tract at points between cylinders 1 and 2, 2 and 3, 4 and 5, and 5 and 6. The central hot-spot is water heated from the coolant system.

On the twin carburettor model, however, separate induction castings are employed. These incorporate curved inverted Y-shaped channels, through which each carburettor feeds two ports to the main gallery tract. As in the single carburettor system, the main gallery is partitioned at the centre, where there is a balance orifice. The front carburettor feeds into the main gallery between the inlet ports of cylinders 1 and 2, and 2 and 3, while the rear one feeds between the inlet ports of cylinders 4 and 5, and 5 and 6. Hot spots are formed by water jackets round the inverted Y-piece castings. Separate air silencers of the AC, L-type are employed and are installed transversely. This arrangement is doubtless more satisfactory from the carburation viewpoint, although many manufacturers prefer to use a single air silencer with a connection across the carburettors. A mechanical fuel pump, mounted on the side of the engine remote from the exhaust manifold, is common to both Armstrong Siddeley models.



A rod and two flexible couplings connect the throttles in the twin carburettor installation of the Armstrong Siddeley Sapphire

Foreign exhibits

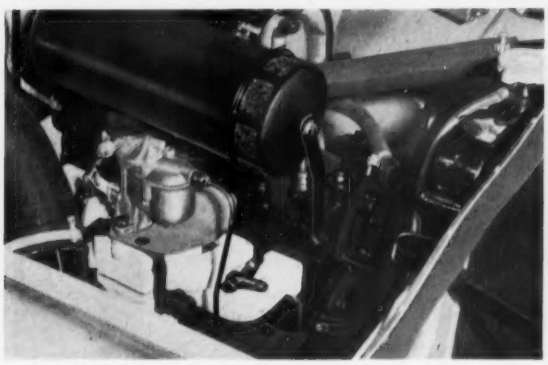
An ordinary two port branch induction system is employed on the Skoda 1200, but the induction manifold is beneath the exhaust instead of above, as is the more common arrangement. A Solex horizontal carburettor feeds the circular section induction manifold, which, being below the axes of the inlet valve ports in the cylinder head, rises as it sweeps inwards to the head. The four port exhaust manifold above has a large flange on its underside, which is bolted to a similar flange on the induction casting to provide a contact hot spot. There is something to be said for reversal of conventional manifold arrangement, for the induction manifold probably keeps a little cooler than it would if it were above the exhaust. This is because convection currents tend to be cool below but hot above the exhaust manifold. From the horizontal, off-take flange at the rear, the down-pipe passes to the exhaust silencer. A long, metal air intake tube sweeps from the air intake of the carburettor, over the engine and to the oil bath air cleaner above the cylinder head.

An unusual feature of the fuel installation is the situation of the petrol tank high up on the engine bulkhead. This gives a gravity feed to the carburettor. While this arrangement dispenses with a pump in which the fuel might be subject to pre-heating, there must be considerable pre-heating of the tank itself, particularly in hot weather. A bowl type petrol filter is attached to the petrol inlet of the carburettor.

Mercedes Benz

Last year, Mercedes Benz exhibited, among other models, the 300 Series, six-cylinder engine with twin, Solex single barrel downdraught carburettors. This year, the 300b, a similar engine of 2,996 cm^3, was shown. It has twin, Solex dual downdraught carburettors. Interesting features include starter carburettor units, thermostatically controlled by a coiled bi-metal spring, and a solenoid-operated float chamber vent to ease hot-starting difficulties in warm climates. The induction layout is of the four port pattern, the intermediate branches feeding siamesed inlet valve ports, and the end ones supplying single ports. Thus, each dual carburettor feeds three cylinders through its own separate induction manifold, the riser tee of which is jacketed for exhaust heating. The design of the air cleaner installation is most commendable. Both air filter units are in a long chamber which has little depth, and fits well down on the carburettors. Each exhaust manifold is connected to a separate silencer.

Also shown for the first time at Earls Court, the Mercedes Benz 300SL is the only touring car in production that is equipped with petrol injection, instead of the conventional carburation system. This six-cylinder engine, of 2,966 cm^3 is installed at an angle from the vertical as viewed from the front so that it lies partly on its left side. The inlet and exhaust manifolds are on the right-hand, or upper side, with the inlet above that of the exhaust. Being some 4 in in diameter, the inlet manifold is large, but the branches are of more usual size for an engine of this capacity. From the main inlet tract, the branches sweep up over the engine to the cylinder head ports. The tracts are of round section throughout and are



A thermostatically controlled hot-spot is employed in the side valve engine for the Hillman Husky

The extremely neat air cleaner installation over the twin, dual downdraught carburettors of the Mercedes Benz 300b

fabricated from sheet metal. A large heat shield of aluminium is placed between the inlet and exhaust manifolds.

The Bosche injection pump is of the orthodox jerk-pump pattern, such as is employed in diesel installations, but with the additional metering control mechanism necessary for the constant volume cycle. It is fitted on the left or underside of the crankcase, and is driven by a shaft from the front of the engine. On the same side are the injection nozzles mounted on the cylinder block, just below the cylinder head joint. The sparking plugs are above them in the cylinder head. While the injection system undoubtedly contributes towards the high power developed by the engine, the installation must be costly. It seems questionable whether it would not be economically better to employ an engine of slightly larger capacity to obtain the necessary power, and use a conventional multiple carburation system.

Fiat

On the Fiat 500, a two port branch induction system is used, the induction being above the exhaust. The two manifolds are cast integrally and a hot spot is formed at their junction. A circular section induction tract slopes downwards from the riser tee, and turns in gentle curves towards the cylinder head. Mixture is supplied by a Weber downdraught carburettor. A metal heat shield is clamped between the carburettor and induction manifold flanges. The exhaust manifold extends outwards beyond the induction, and the off-take flange is located in the centre of the manifold casting. A small, cylindrical air silencer is connected to the carburettor inlet by means of a curved metal tube.

On the Fiat 1900, a totally different system is employed. A Weber dual downdraught carburettor is used. The induction arrangement is the classic Ricardo design, and the throttle spindle of the dual carburettor is at right angles to the engine crankshaft. Each throttle barrel supplies a separate tract, the barrel nearest the engine feeding cylinders 2 and 3, the outer one cylinders 1 and 4. The tracts are of circular cross section, and slope downwards from the riser tees to the cylinder head inlet ports. In this instance, the induction and exhaust manifolds are separate castings bolted together at the centre to form a hot spot. Heat protection is afforded by a metal heat shield between the carburettor and induction flanges. A cylindrical air silencer is mounted longitudinally above the cylinder head, and a metal pipe leads down to the air intake of the carburettor.

American Ford Thunderbird

An interesting example of American sports car design is the Ford Thunderbird. This is powered by a version of the Ford, overhead valve, V8 engine of 3,910 cm^3 capacity, and is fitted with a four barrel downdraught carburettor of Holley manufacture. The power unit is of a compact and ingenious design of the high standard usually associated with Ford engineering. As in nearly all American V8 engines, the induction system incorporates a number of coolant and exhaust hot-spot induction tracts, all within a single casting that bridges the vee between the two cylinder heads.

The induction tract arrangement is unusual. Instead of the inlet ports in the cylinder heads being side by side, as in conventional V8 practice, they are one above the other in pairs. The induction manifold casting has been arranged accordingly, but it remains a most complicated casting, full of cross-over induction tracts, exhaust and coolant channels. Instead of the usual dual downdraught carburettor, a four-barrel instrument is now employed. With this arrangement the left-hand pair of throttle barrels feed the two upper branch ports at the rear and the two lower ones at the front. Conversely, the right-hand pair of throttle barrels supply the two upper ones at the front and the two lower ones at the rear.

Since the inlet valve ports in the cylinder head are one above the other, the upper one has to turn sideways in the casting and down to meet its inlet valve, while the lower one turns sideways and upwards.

In addition to the induction tracts, there is on each side of the manifold casting a single exhaust duct branch, through which, during warm-up, exhaust gases are passed to the hot-spot jacket round the riser. A thermostatically controlled heat valve, in the right-hand exhaust manifold, ensures that the gases are directed through the hot-spot jacket until normal running temperature is reached; after this they are passed into the exhaust system.

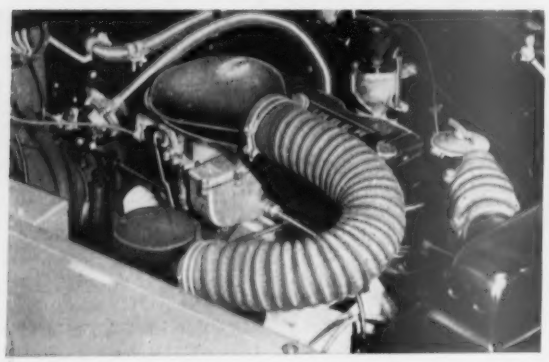
Yet another channel in the manifold carries the hot coolant from each cylinder head to the radiator. This duct runs transversely from one cylinder head to the other, the outlet being in the middle of the front of the manifold casting.

The vehicle has an extremely low bonnet line, and the design of the oil bath air cleaner, which fits right down over the carburettor and surrounds it, is admirable. On this model, separate exhaust manifolds on the outside of each cylinder head lead down to individual exhaust silencers. The carburettor incorporates the usual American type of hot air, automatic choke.

Vedette 55

Exhibited at the London Motor Show for the first time was the new Ford S.A.F., 2,353 cm^3, V8 engine in the Vedette. Its carburation system follows conventional practice. A dual downdraught carburettor is mounted on the induction manifold casting, the throttle barrels feeding the inner pair of port branches on one side and the outer pair on the other. In this instance, the port branches are side by side, as in previous Ford practice, instead of being one above the other, as in the overhead valve engine in the Ford Thunderbird, which has already been described.

The carburettor is a Zenith dual downdraught unit, but with a Solex type of starter unit behind its body. This starter carburettor is operated by a cable control in the usual manner. A small cylindrical air cleaner is fitted directly on the carburettor entry. Fuel supply is by a mechanical fuel pump, high up on the right-hand side at the rear of the engine.



In the new overhead valve engine installation for the Humber Hawk, flexible hose is employed in the air intake system

This oil bath air cleaner surrounds the body of the carburettor on the Ford Thunderbird

CLUTCHES

More General Adoption of Hydraulic Control

WHILE it would be premature to state that friction clutch design as applied to British cars has reached finality, it was evident from the examples seen at this year's exhibition that incentive to improvement has been lacking. The large majority of clutches differ little, if at all, from those fitted to vehicles shown at Earls Court a year ago. These remarks, of course, apply to the single dry plate type, with a coil-spring loaded pressure plate, and a driven plate with or without a flexible centre incorporating steel springs or rubber to absorb transmission vibrations. Apart from these main features, there is a choice of certain details to suit different preferences and applications, but in most cases these, too, have for a long time fulfilled their functional requirements without important changes. Judging from the cars exhibited, two of the main tendencies noted last year have extended. One is the increased adoption, either as standard or alternative provision, of transmission systems that eliminate the need for a friction clutch altogether. The other is the substitution of hydraulic, in place of mechanical, clutch operation; a development applied to many foreign as well as British-built cars.

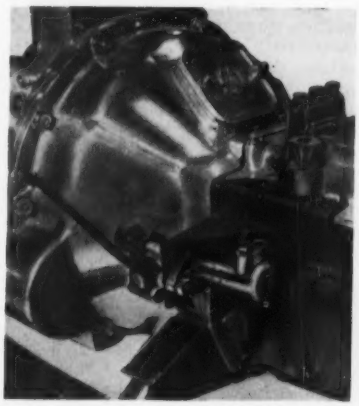
Even in cases where the clutch pedal is located conveniently close to the clutch withdrawal mechanism, and only a simple form of mechanical linkage is required, allowance has to be made to accommodate rocking movements of the engine, clutch and gearbox unit on their flexible mountings. Mechanical linkages are liable to cause rattles and lost motion, particularly as a result of wear. They also require lubrication and occasional renewal of bearings or bushes, and alternative provision has to be made to suit right- and left-hand drives.

With the hydraulic type of control, these troubles are, of course, entirely avoided, since actuation of the clutch withdrawal mechanism is effected by a hydraulic slave cylinder, which can be mounted in any appropriate position on the clutch bell housing or gearbox. A flexible pipe is the only connection between the clutch and the hydraulic master cylinder operated by the clutch pedal. The equipment occupies little space, provides positive and practically frictionless operation and requires no lubrication.

The operating equipment for the Girling hydraulic clutch fitted on many British cars is extremely simple. It comprises a pendant clutch pedal, master cylinder, slave cylinder, flexible pipe and fluid reservoir. For light cars, the master cylinder and reservoir form a combined unit, with the plunger connected directly to the pedal. The slave cylinder is designed for mounting on the bell-housing. For larger vehicles, a separate fluid reservoir is provided and the slave cylinder is of the flange-fixing type normally mounted on a bracket adjacent to the bell housing. In both applications, movement of the master cylinder plunger first shuts off the supply from the reservoir, and then displaces fluid through the pipe connection to actuate the slave cylinder piston and withdraw the clutch.

Though similar in operating principle, the Lockheed equipment introduces the advantages of simplicity and low cost by combining the master cylinder with that used for applying hydraulic brakes. The two cylinders form a compact unit that has separate fluid reservoirs but a common filler. There are, of course, separate outlet connections for clutch and brake actuation. The slave cylinder is flange-mounted and usually has a direct, push rod connection to the withdrawal lever.

From the maintenance standpoint, these hydraulic systems are undoubtedly attractive. They should function satisfactorily for long periods with a minimum of attention, provided care is exercised to guard against entry of air into the master cylinder. Air will enter, of course, if the level of the fluid in the reservoir be allowed to fall too low, or should any portion of the system be disconnected. If it does enter, bleeding of the system becomes necessary. Important requirements are that only fluid recommended by the makers be used and that it is clean.



Girling hydraulic slave cylinder for clutch withdrawal on the A.C. Ace

Few examples of the centrifugal type of clutch were seen in the exhibition. The 9½ in diameter unit, used in conjunction with an electrically controlled pre-selector gearbox on the Armstrong Siddeley Sapphire, is an optional feature and was described in the January 1954 issue of *Automobile Engineer*. It is of the Newton Bennett type but, with the exception of the Newton cushion clutch plate, is produced by the chassis manufacturers.

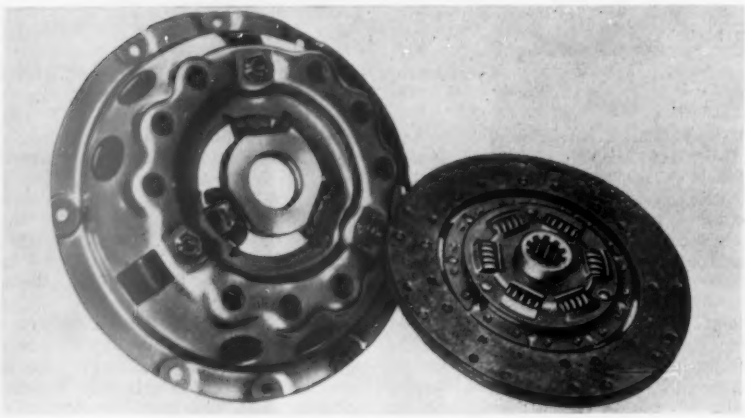
A Borg and Beck centrifugal clutch has been specially developed for, and is an essential feature of, the Manumatic control produced by Automotive Products Co. Ltd. As is well known, this control eliminates the clutch pedal and enables an inexperienced driver to make an absolutely smooth and shockless gear change simply by movement of the gear lever. The change is effected by the combined action of vacuum servos that utilize the suction from the engine induction system (under control of a solenoid actuated valve, a control valve and synchronizing switch) to actuate the clutch and throttle. Though centrifugal in action, the clutch is also provided with a normal release lever mechanism to permit the engine to be started either by towing the vehicle or by coasting down a gradient. Provision is made whereby the release bearing may be moved rearwards, so that the load it applies to the release levers below a certain engine speed is relieved. In these circumstances, the clutch is allowed to engage in the normal manner, irrespective of the fact that the centrifugal elements are in the disengaged position. This control is operated by a hand lever, and after the engine has been started the system can be returned to automatic actuation. In its latest form, the equipment has the control valve and other features, except the clutch servo and vacuum reservoir, combined in one.

The interest created by the recent introduction of electromagnetic types of clutches may have aroused expectations that they would appear at the Show. However, none was exhibited, but it was learned that the British example, the Smith Eaton unit, is undergoing exhaustive tests. Although it is giving very promising results, it has not yet been adopted for any standard production vehicle. The engagement of this type of clutch, it will be remembered, depends upon the gripping action on the driven plate of a magnetic field passing through ferromagnetic particles, the whole unit being contained within the engine flywheel. A solid, non-slip drive, unlike that afforded by the fluid flywheel, is obtained, but when the gear shift lever is moved initially to make a gear change, the current giving rise to the magnetic field is switched off and complete disengagement results.

Acting also on the electro-magnetic principle, the Ferodo magnetic clutch developed in France is under test by Renault, and it is expected that it will be available as optional equipment for this make of car early next year. The Ferodo unit differs from the Smith Eaton one in that it is more like a conventional clutch and the presser plate is actuated by magnetic force instead of coil springs.

Differences of opinion persist as to

the relative merits of moulded and woven asbestos-based materials for clutch disc facings. However, both varieties continue to be produced by the majority of makers in order to comply with the demands of chassis manufacturers and to meet the requirements of different applications. There appears to be an increasing preference for the moulded facing for light and medium powered cars, and a number of new types, both metallic and non-metallic, in this category have recently been introduced. The metallic types, of course, have brass wire reinforcement. Of the non-metallic materials, the latest product of Mintex and Ferodo have shredded asbestos moulded with other materials, and are said to combine better anti-slip and good wearing properties. They also possess a degree of flexibility which reduces the liability to fracture when being riveted to discs.



The Borg and Beck 'A' type range of standard clutches and driven plates covers 6¼ in to 11 in diameter units suitable for modern private cars

GEARBOXES

Increased Popularity of Overdrive Units

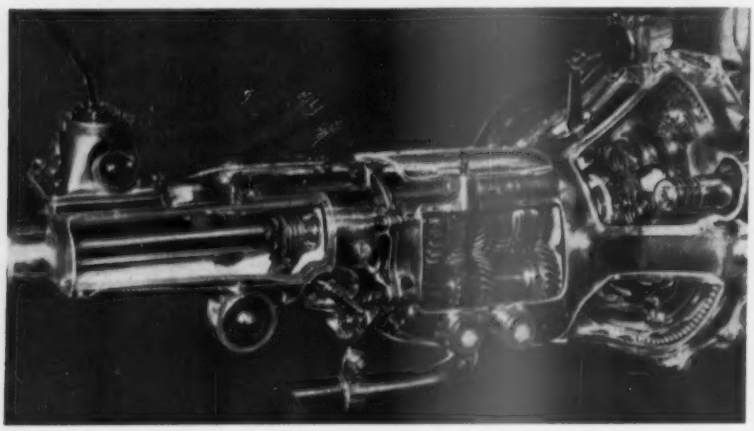
WHILE there is at present no sign that automatic transmissions will be widely employed in British made cars in the near future, there is a definite trend towards the employment of an overdrive, either as a proprietary unit in conjunction with the normal gearbox or incorporated in the gearbox. In the British quantity-produced cars in which an overdrive is offered as a standardized or as an optional fitting, the Laycock-de-Normanville unit, with its well known semi-automatic control, is the proprietary unit most commonly employed. Only in rare instances is an overdrive unit offered as additional equipment on American vehicles.

Hitherto, automatic transmissions for British cars have been based mainly on American designs, and have been available only on cars with engines of more than three litres capacity. Therefore, the Hobbs transmission with an over-riding control, as employed in the new 1½ litre Lanchester Sprite, is a development of considerable interest. There is a definite demand for two-pedal control in low and medium powered cars. This demand can be met either with an automatic transmission or an automatic clutch linked operationally to a conventional synchromesh gearbox.

There are a number of automatic clutches suitable for semi-automatic transmission systems. Of these units, perhaps the one in the most advanced stage of development is the Manumatic control. This unit, which is based on a centrifugal clutch and a vacuum operated withdrawal mechanism was described in the February 1953 issue of *Automobile Engineer*.

Another is the Ferlec magnetic clutch, introduced at the Paris show this year. This unit is manufactured by Ferodo, Avenue de la Grande Armée, 64, Paris. Like conventional clutch units, it has a presser plate and a driven plate faced on each side with a metallic friction material, but the presser plate is actuated by an electro-magnet instead of coil springs. The clutch is disengaged by breaking the electro-magnet circuit.

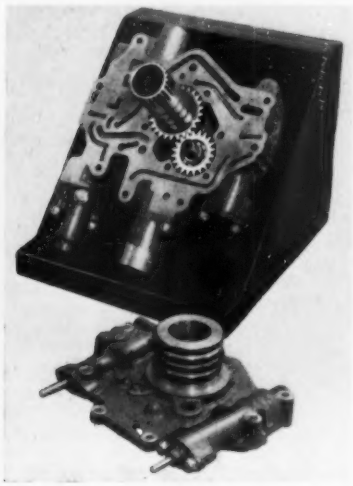
The same manufacturers have developed a centrifugal clutch for semi-automatic control systems. This unit is called the Gravina. It is ingenious, though perhaps a little complicated. The carrier for the centrifugal weights has a relatively low polar moment of inertia. It is free to rotate or to remain stationary independently of the remainder of the unit, except in as much as it is constrained by a friction clutch that locks it to the cover of the unit. An electro-magnet is used to disengage this friction clutch and slow down the rotating weights during gear changes.



On the M.G. Magnette the gear shift control is carried in a turret at the rear end of the gearbox assembly

The four forward speed and one reverse gearbox in the Aston Martin DB3S competition car is operated by a central, remote control shift mechanism. This gearbox, with ratios of 10·8 : 1, 6·97 : 1, 4·69 : 1, 3·727 : 1 and 10·88 : 1 in reverse, replaces the five-speed transmission used on the original DB3 vehicle. It is similar in basic design to the units used in the older Aston Martin models, except that the gears are carried on needle roller bearings instead of bushes. In all Aston Martin and Lagonda gearboxes, needle roller bearings are employed to carry the layshaft cluster. Additional support is afforded to both the mainshaft and the layshaft by intermediate roller bearings.

The David Brown model S532 gearbox has five forward speeds and one reverse, top gear being an overdrive; the



The Hobbs hydraulic unit assembly

box ratios are: fifth 0·825 : 1, fourth 1 : 1, third 1·195 : 1, second 1·73 : 1, first 2·7 : 1 and reverse 2·31 : 1. All forward gears except first have inertia lock synchromesh engagement. First gear is engaged by means of a sliding, toothed clutch, and reverse is a crash engaged sliding spur gear. This gearbox is designed for use with a gear lever mounted either at the rear of the box or mid-way along its offside, or with a steering column control. The gear case is of aluminium and is split in the plane of the axes of the main and layshafts. It has an integral clutch housing, and an intermediate web is incorporated to carry the mainshaft centre bearing.

The case hardened, En 36 mainshaft is carried in roller bearings at the front and intermediate positions, and in a deep-groove ball bearing at the rear. To save space, the shaft is shouldered and forms the inner race of the intermediate roller bearing which is retained by a case-hardened steel washer. The forward gears on the mainshaft are each carried on two rows of needle roller bearings separated by hardened steel distance rings.

A case hardened, En 36 primary shaft, integral with its gear, is carried in a deep groove ball bearing in a housing insert in the front wall of the case. The inner race of the bearing is pulled up against the front face of the gear by a left-hand threaded nut, and the outer race is retained by the front cover. This cover is spigoted into the housing and bolted to the front wall of the box.

At the rear end of the primary shaft is a cylindrical extension. It is counterbored to form the outer race of the bearing in which the front end of the mainshaft is carried. Fitted over this extension is the integral cone and tooth-ring of the synchro unit. There are 39 teeth at 13 D.P. Six slots are machined on the end of the extension and in them register internal dogs in the cone and tooth-ring component. Also in the bore of this component is a groove to receive a snap ring which, before assembly, is placed in a groove round the extension and which springs into position when the unit is assembled.

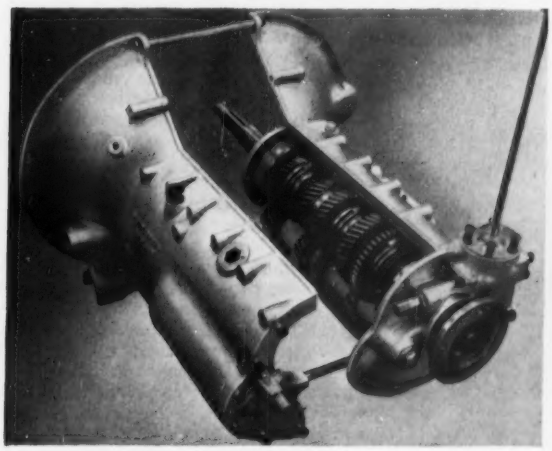
The cast aluminium-bronze synchro cups also have tooth rings round them and are floating on the cones. They are prevented from rotating relative to the mainshaft by three En 36 saddles. The ends of these saddles extend into slots in the cups on each side of the centre component of the synchro unit. In the centre of each is a hole, in which is housed a $\frac{9}{32}$ in diameter ball. This ball registers in a detent in the internally toothed sleeve member that surrounds the assembly. It is free to roll on the outer end of a spring-loaded, hardened steel plunger in a radial hole in the centre component of the synchro unit. The saddles, of course, are each housed in a slot formed by omitting one tooth from the periphery of the centre component. During the initial movement of the sleeve to engage the gear, the assembly comprising the synchro unit is moved axially. The three saddles push the cup into engagement with the cone, and when synchronization is effected, the sleeve rides through the teeth round the cups and engages those round the cone. Since the cone and cup included angles are 14 and 14½ deg respectively, contact first takes place at the small end and gradually spreads across the whole surface as the cones deflect to bed in. No doubt, this arrangement gives a snap disengagement action as well as smooth engagement.

In principle, the other synchro units are the same. The unit between the second and first speed gears has a synchro cone and cup for the second speed gear only; first speed is engaged simply by sliding the sleeve member to the rear into engagement with a tooth ring integral with the first speed gear. There is a single unit for the overdrive gear towards the rear end of the box, and reverse gear is integral with the sleeve of the overdrive synchro unit.

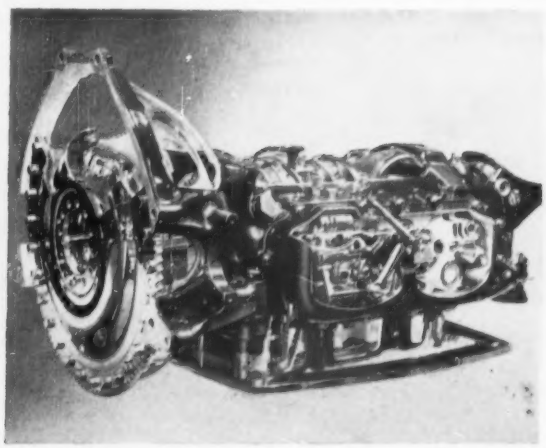
The speedometer wheel is mounted behind the rear mainshaft bearing and a forward extension of it carries a muff through which the oil passes from the pump via a filter to an axial hole in the mainshaft. From there it is distributed to the needle roller bearings that carry the mainshaft gears. There is a relief valve on the delivery side of the pump. A magnetic plug is fitted to the gearbox to collect any ferrous particles in the oil.

The En 36, hollow layshaft cluster is mounted on two double-row roller bearings round each end of a dead shaft. The rollers are $\frac{1}{2}$ in diameter. Axial thrust is taken by a phosphor bronze thrust washer at each end. There are two gears integral with the cluster and the remainder are pressed-on and dog driven. The reverse idler is pressed and keyed on to its spindle, which is carried in a flanged phosphor bronze bush at each end. Interposed between the flanges of the bushes and the idler are case hardened En 34 thrust washers. The end of the spindle is slotted to drive the gear type oil pump.

On the Austin Westminster, the four forward and one reverse synchromesh gearbox gives the following overall ratios: 12·962 : 1, 8·055 : 1, 5·61 : 1 and 3·91 : 1, reverse being 17·568 : 1. A



The fifth speed in the David Brown S532 gearbox is an overdrive and is at the rear



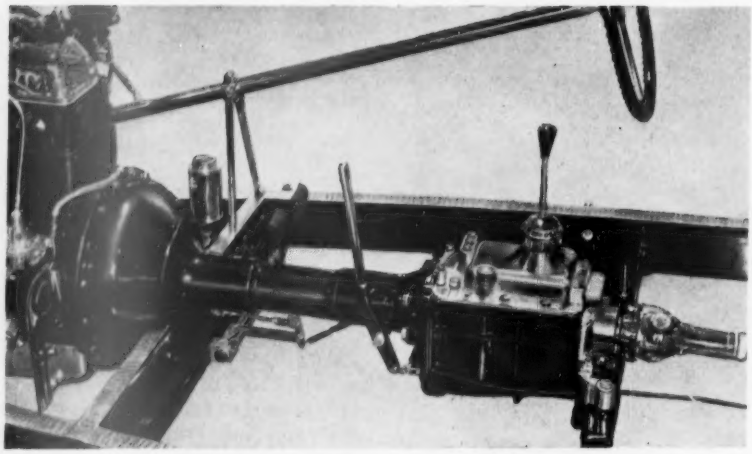
The Rolls-Royce transmission, like all other automatic units, requires skilled attention if maintenance is necessary

steering column control is employed. The synchromesh units incorporate an inverted lock form of baulk ring developed by the British Motor Corporation. With this arrangement, there are three bevelled lugs projecting at right angles from the die-cast aluminium bronze check ring. These block the passage of the coupling sleeve to prevent engagement of the coupling dogs until complete synchronization has been effected. The speed of engagement is related directly to the pressure exerted on the gear lever.

A new feature on the Sunbeam Alpine is a Laycock-de-Normanville overdrive unit, which is also available as an optional fitting on all other models of the Sunbeam range. Without the overdrive the overall ratios are: 3·90 : 1, 5·811 : 1, 9·63 : 1 and 12·43 : 1. When the overdrive is fitted, the axle ratio is lowered slightly to give better acceleration in normal top gear, and the gear ratios on the saloon and convertible are 3·28 : 1 (overdrive), 4·22 : 1, 6·297 : 1, 10·434 : 1 and 13·455 : 1. With the close ratio gearbox of the Alpine model, the ratios are as follows: 3·28:1, 4·22:1, 5·61 : 1, 9·24 : 1 and 11·94 : 1. The overdrive, which is solenoid operated, is controlled by a switch situated on the base of the steering column boss.

The Laycock-de-Normanville overdrive, now available on the Jaguar Mark VII type M saloon, is mounted directly on the output shaft of the four-speed gearbox. It is employed in conjunction with a rear axle that has been modified to give a ratio of 4·55 : 1 instead of 4·27 : 1. This is likely to improve top gear acceleration by approximately 10 per cent. An overdrive ratio of 3·538 : 1 has been adopted, and the centrifugal governor switch is set to engage the overdrive automatically whenever 36 m.p.h. is exceeded in top gear. The translucent plastics lever of the manual control switch of the overdrive unit is on the facia panel.

A new feature of the Bristol 405 saloon is that it is equipped with a Laycock - de - Normanville overdrive. This unit is bolted directly on to the four-speed synchromesh gearbox. The overall ratios are: 15·21 : 1, 7·71 : 1, 5·46 : 1, 4·22 : 1 and 12·20 : 1 in reverse, and the overdrive ratio is 3·28 : 1. A lightly loaded toggle switch on the instrument panel operates the overdrive solenoid unit, the switch being held on by a smaller solenoid which releases it if top gear is disengaged.



In the well known Morgan chassis, the gearbox is installed some distance behind the clutch and engine

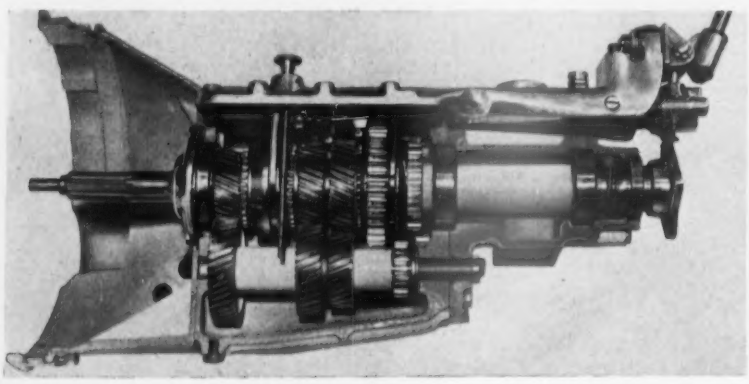
The synchromesh gearbox of the Wolseley Six-Ninety gives the following overall ratios: 13·59 : 1 8·45 : 1, 5·88 : 1 and 4·1 : 1, reverse being 18·4 : 1. This gearbox, following the B.M.C. trend of rationalization, is similar to the one employed on the Austin Westminster. In fact, certain components are directly interchangeable. The light alloy extension on the rear of the gearbox casing carries a plain bearing in which is the propeller shaft sliding joint. On the outside of the extension are machined two flats to seat on the rubber-to-metal bonded mountings.

The Hobbs automatic transmission with an over-riding control is employed in the Lanchester Sprite. It has been developed jointly by Hobbs Transmission Ltd. and the Lanchester Motor Co. Ltd. The basic principles of this type of unit were outlined in the 1953 London Show Review issue of *Automobile Engineer*. Its main elements have not been changed. They are: two friction clutches, a compound epicyclic gear and a series of friction brakes which, in conjunction with the clutches, control the selection of the four forward ratios and reverse. Detail modifications have been made to the hydraulic system that actuates the clutches and brakes. The overall ratios are: 16·83 : 1, 9·77 : 1, 6·72 : 1, 4·44 : 1 and reverse 21·0 : 1.

On the Buick Series 61, a synchromesh gearbox is available as an alternative to the Dynaflow automatic transmission. This synchromesh gearbox is larger and slightly different in design from the one used in the earlier models. The gear ratios are 2·39 : 1, 1·53 : 1, 1 : 1 and reverse 2·53 : 1.

The primary gear shaft extends forwards and its front end is carried in a single-row ball bearing in the rear end of the crankshaft. Support for the gear is afforded by a ball bearing in the front wall of the box. Its rear end is counterbored to receive the fourteen rollers of the bearing in which the front end of the mainshaft is carried. The rollers are retained by a washer and snap ring. At the other end, the mainshaft is carried by a ball bearing in the rear wall of the box. The layshaft cluster is on two roller bearings on a dead shaft, which is located by a pin driven into a diametral hole at the rear of the shaft. A tubular spacer and two thrust washers round the shaft separate the roller bearings, and a retaining washer at the outer end of each bearing holds the rollers in position. Axial thrust is taken by a bronze washer at each end.

As with the layshaft gear, the reverse idler is carried on a pinned shaft, and the bearing arrangement is similar. The second speed gear is bronze bushed and is mounted on the mainshaft between a shoulder and a thrust washer retained by a snap ring. Splined on the mainshaft, to the rear of the second speed gear, is the first and reverse sliding gear. It can be moved forwards to engage the layshaft gear for first speed or rearwards to engage the reverse idler.



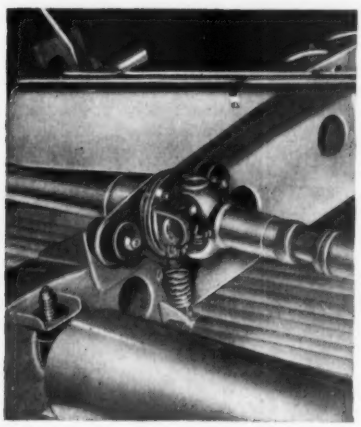
This sectioned gearbox for the Mark VII Jaguar was exhibited on the stand of Moss Gear Co. Ltd.

PROPELLER SHAFTS

Detail Developments along Conventional Lines

WHILE without exception the British and Continental cars exhibited had open propeller shafts, some of the American cars still incorporate the torque tube type. This is, however, not a general trend in American made cars, but is mainly confined to vehicles which employ coil springs and banjo type axle units for the rear suspensions.

In the Austin Cambridge and Westminster saloons, the sleeve component of the sliding joint of the propeller shaft assembly is supported in a plain bearing in an extension of the gearbox rear cover. Although the basic layout of the propeller shaft arrangement on both cars is similar, the shaft dimensions are different. The propeller shaft in the Aston Martin DB3S competition car is fitted with Hardy-Spicer joints. It is slightly shorter than the one used on the Aston Martin DB3 owing to the position of the spiral bevel final drive unit which is attached by a rubber bushed mounting to two tubular cross members at the upswept end of the chassis frame. Although this layout increases slightly the height of the propeller shaft line, this is a negligible factor in this type of vehicle.



Hardy Spicer, flexibly mounted intermediate bearing on the Rover 90

A torque tube drive is employed in the Buick Series 61, and the universal joint is splined to the rear end of the transmission shaft. The joint is entirely enclosed by an extension of the transmission shaft bearing retainer and by the torque ball which is flanged and bolted to the torque tube. Hardened and ground steel bushings, held in the universal joint yokes by retainer rings, provide bearings for the hardened and ground pins of the universal joint spider. A sleeve extension of the rear yoke is splined internally to engage the propeller shaft and is ground externally to provide a journal to run in a bronze bush in the torque ball. To prevent picking up and scoring during the running-in period, the torque ball, which is supported between an inner and outer retainer, is copper plated on the bearing surface, as are the retainers.

The universal joint and torque ball are automatically lubricated from the gearbox. Oil enters the rear bearing retainer through a hole at the top and returns to the gearbox through a hole at the bottom. A synthetic rubber boot, extending from the outer retainer to the flange of the torque ball, provides an external oil seal. The torque tube encloses a tubular propeller shaft which is rigidly connected to the pinion through a splined joint and a pin. A seal mounted in the torque tube front flange bears against a sleeve pressed on the front end of the propeller shaft to prevent passage of lubricant between the transmission and the rear axle. The torque tube is flanged and bolted to the differential carrier.

The only difference between the transmission layouts of the Alfa-Romeo 1900 T.I. exhibited and the original model, known as the 1900, is in the universal joints employed in the divided propeller shaft. On the original 1900 model these were hexagonal, with three-armed spiders. However, on the 1900 T.I. model, where the engine output has been increased from 79 b.h.p. at 4,800 r.p.m. to 100 b.h.p. at 5,500 r.p.m., they are octagonal and carry four arms and are adequate to cater for the increased torque transmitted, even when the engine is tuned to develop 120 b.h.p. at 6,000 r.p.m.

The internally splined sliding joint on the Hardy Spicer stand

REAR AXLES

No Major Changes: Wider Adoption of Hypoid Gears

FEW basic changes could be distinguished in the design of rear axles. The hypoid bevel gear differential unit is gaining in popularity and is now employed in the majority of British models. This also applies to most of the American cars that were exhibited. Continental manufacturers exhibited on their vehicles a variety of rear axle layouts but without any real departure from conventional practice. In detail design, there are indications that British and American axle manufacturers are paying more attention to those features that facilitate initial assembly and adjustment. This will lead also to simplification of servicing.

Salisbury hypoid rear axles exhibited with crown wheels ranging from 6½ in to 9¾ in pitch diameter are all of the same basic construction. The gears are housed in a one-piece, black heart malleable casting with cored channels for oil circulation. A pressed steel cover bolted to the rear of this casting is of such a shape as to assist the flow of oil induced by the gear. Taper roller bearings carry the overhung pinion and the differential assembly. Shim adjustment is provided for the meshing of the gears and control of the bearing preload. Bolted-on bearing caps retain the differential bearings.

Case hardened, En 35A alloy steel differential gears are carried in a one-piece malleable cast iron differential case, to which the drive gear is secured by set bolts. The differential pinions are carried on an En 35A spindle, which is retained by a pin driven through the cage and a hole drilled diametrically through the shaft. Flats are machined on the differential pinion spindle to allow oil to pass to the bearing surface.

Axle tubes of 0·30-0·35 per cent carbon steel are pressed in and secured by welding. The taper roller bearings in the tube ends are subjected to thrust loading in the outward direction only, inward thrust being transmitted, through the shafts and a slotted spacer between their inner ends, to the bearing on the other side of the axle.

The type 4HU drive unit for use with independent rear suspension, incorporates the basic components of the type 4HA axle with its 8½ in pitch

diameter hypoid gear with 1½ in pinion offset. Mounting pads are cast integrally with the modified gear housing for installation in the chassis. One pad, with four tapped holes, is on top of the unit, while the other takes the form of a drilled flange round the nose. The internal assembly is similar in most respects to that of the beam axle, but the short axle shafts are flanged to receive Hardy Spicer universal joints. Each shaft is carried by two opposed, taper roller bearings housed in the main casting, the bearing cones being retained by a nut and tab washer on the shaft. Since each shaft assembly takes thrust in either direction a spacer is not needed, and the opposed bearings are clamped between an abutment shoulder in the bearing bore and retaining plate bolted on externally.

For the final drive unit in the new Austin Cambridge, a hypoid bevel gear is employed instead of the bevel gear unit of the model that this car replaces. When the vehicle is equipped with a 1·2 litre engine, as in the A40, the final drive ratio is 5·125 : 1, and in the A50, where a 1·5 litre engine is employed, the final drive ratio is 4·875 : 1. A hypoid bevel gear, final drive unit with a reduction ratio of 3·91 : 1 is employed in the Austin Westminster. The unit is housed in a pressed steel, banjo type rear axle casing of conventional design.

A compact, spiral bevel, final drive unit with a four-pinion differential, on the Aston Martin DB3S competition car replaces the hypoid final drive unit with inboard brakes that was used in the Aston Martin DB3. Although the use of a spiral bevel unit slightly increases the height of the propeller shaft line, this is not of great import-

Salisbury 4HV final drive unit for use with independent rear suspension

ance in this type of car. This bevel drive unit is attached to the frame by a rubber bush mounting at the top and a rubber mounted cross tube at the bottom. It has a ratio of 3·727 : 1. Two main factors led to the adoption of this type of unit. First, the possibility of providing a wide choice of gear ratios at lower cost than would be possible with a hypoid arrangement, and secondly, the need for keeping the operating temperature of rear axles as low as possible in competition cars.

In the new Lanchester Sprite, a Salisbury hypoid bevel rear axle with a reduction ratio of 4·1 : 1 is employed. This rear axle has a one-piece differential casing into which the axle tubes are fitted. Opposed taper roller bearings support both the hypoid pinion and the two-pinion differential cage, to which the crown wheel is bolted. Taper roller bearings support the outer ends of the axle shafts. They are arranged so that the axial loading due to cornering is transferred to the more lightly loaded inner wheel via a central thrust pad, between the two half-shafts. The brake back plate is bolted to the welded-on ends of the axle tubes and the rear wheel hubs are keyed to the tapered ends of the half-shafts.

The rear axle assembly of the Buick Series 60 is of the semi-floating type. It has a hypoid bevel gear. Where a synchromesh gearbox is fitted, the axle ratio is 3·9 : 1, and with a Dynaflow automatic transmission, an axle of 3·4 : 1 ratio is adopted. The torque tube surrounding the propeller shaft is bolted to the differential carrier to form one unit, called the third member housing. This third member housing is bolted to the banjo type axle housing. Two rods brace the front end of the third member housing to the outer ends of the axle tubes. The hypoid pinion is carried by two Hyatt roller bearings at the rear and a New Departure double-row ball thrust bearing at the front.

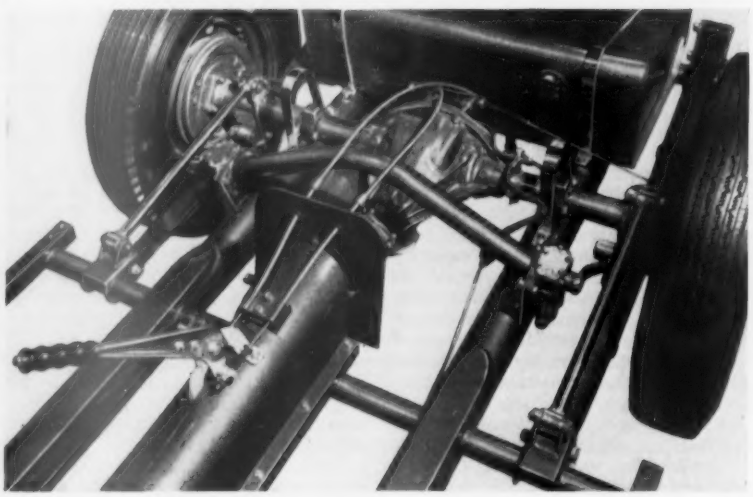
The crown wheel is riveted to the differential carrier which is on two taper roller bearings. Ring nuts are tightened against the outer races of the bearings to adjust their pre-load and the mesh of the crown wheel. The two differential pinions are carried on a spindle which is anchored in the cage by a set screw. Horseshoe washers retain the axle shafts in the differential gears. These washers are housed in recesses in the gears. A spacer is interposed between the inner ends of the shafts and controls their axial float. At their outer ends the shafts are supported in the axle housing by grease-packed Hyatt roller bearings protected on each side by seals.

REAR SUSPENSION

Trend Towards Greater Deflections, and More Attention to the Prevention of Noise Transmission to the Body

THERE were no entirely new features in rear suspension design among the vehicles exhibited this year. However, there were indications of gradual changes in conventional practices. Almost all the new models have been designed for larger wheel deflections. This invariably necessitates the use of slightly larger shock absorbers. Among the sports cars there were some interesting examples of rear suspension layouts. These, of course, are not always economically practicable for quantity produced cars.

The rear suspension of the Jaguar D type sports car, which is now available to the general public, consists of a live axle, trailing links and a torsion bar spring. Two box section members of large cross section, attached vertically to the main body structure, carry the bearings for the trailing links. The top links are 16 in long and are of steel plate approximately 2 in × ½ in section. Rubber bushes are used for both the inner and the outer bearings. For the



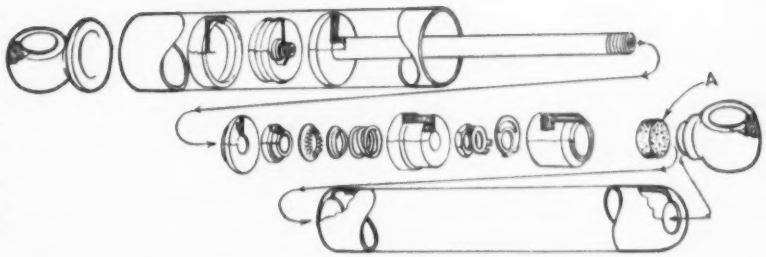
Radius rods are employed in conjunction with the leaf springs in the Swallow Doretti rear suspension

bearings of the lower links, metal bushes are used. They are 1⅝ in diameter and are lubricated through grease nipples. These links also are of steel plate and, as their centre-to-centre length is the same as that of the upper links, the system is of true parallelogram form.

A single torsion bar spring is employed. It is enlarged at the centre where it is attached to a reaction bracket bolted to the main body structure. The effective length between this bracket and the splined outer ends of the bar is 20 in. Fitted on these ends is a sleeve that is internally and externally splined to form a vernier coupling by means of which the attitude of the trailing links can be adjusted. The sleeve is carried in bosses riveted to the inner ends of the lower links. These bosses also form the pivot bearing units of the links. Under cornering conditions, the suspension links are in torsion and their stiffness influences the roll stiffness of the vehicle. Transverse location of the axle unit is effected by an A-shaped stay. The apex of the stay is attached to the axle casing and the legs are pivoted on the vertical members that carry the trailing links. This bracket, of course, determines the height of the roll centre at the rear.

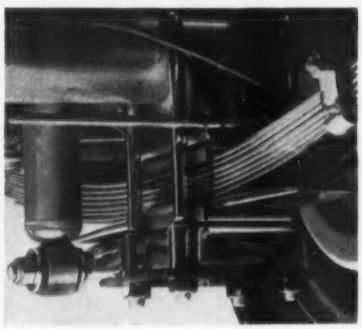
On the Aston Martin DB3S competition car, the rear suspension has been developed from that employed on the DB3 model. In the earlier model, a Panhard rod was used for transverse location of the de Dion type rear suspension, but to provide more positive location, the 2½ in diameter axle beam of the DB3S is fitted with a central slide block made of Tufnol. This block operates in mild steel guide plates bolted to the light alloy final drive cover.

Transverse torsion bars, placed one above the other, and a system of parallel trailing links form the suspension system. The upper suspension arms are tubular, with rubber bushes at both ends, while the lower members are manufactured from carbon steel plates ⅛ in thick. These lower members, which have a certain amount of torsional flexibility, are designed to twist if a load is applied to one wheel only and therefore influence the roll stiffness of the suspension.



In the Spax telescopic hydraulic damper, a porous disc, the Spaxamatic flow control disc A, regulates the rate of flow of fluid from one side to the other of the piston, and there is a minimum of moving parts

In the rear suspension of the Wolseley Six-Ninety, coil springs are employed, and two trailing links and a Panhard rod locate the axle casing. The links are about 41 in long and are inverted channel - shaped pressings, attached near the outer ends of the axle tubes; rubber is interposed between the axle and the links. They are pivoted in rubber bushed bearings about 6 in apart on each side of the centre of the third cross member of the frame. These two links react the torque and thrust. In addition, there is a Panhard rod extending from a point at the rear of the right-hand end of the rear axle to the left-hand side member of the frame. Rubber-to-metal bonded bushes are fitted to the ends of the Panhard rod.



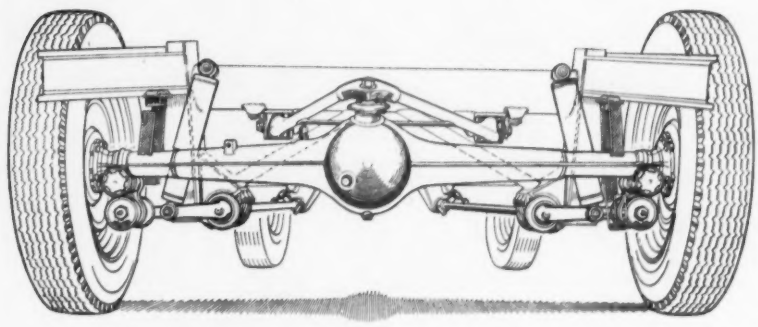
The rear springs on the Rover 90 are clamped between rubber pads

The coil springs are in front of the axle. Their lower ends are carried in pans welded on top of the radius arms. The telescopic dampers are installed coaxially with the springs. Their lower ends are closely finned to help reduce working temperature. The top of each coil spring extends up inside the box section chassis frame side member which is pierced and suitably reinforced at this point.

Coil springs are also employed in the rear suspension system of the Buick Series 61. The upper ends seat in pans on a frame cross member and their lower ends are welded to the axle housing near its ends. A double-acting hydraulic shock absorber is mounted on each rear brake back plate and connected to the frame by a rubber bushed steel link. Sideways movement of the axle is prevented by a rubber bushed Panhard rod.

In the Cadillac Series 60, semi-elliptic leaf springs with full length strips of plastics material between the leaves are employed. The springs are rubber bushed at each end, and a rubber pad is interposed between the spring and its seat on the axle. Telescopic shock absorbers are fitted.

The rear suspension of the B.M.W. 502 is identical with the 501 model. Circular section torsion bars are employed. They are mounted just inboard of the frame side members. Their front ends are carried by a bracket on a frame cross member immediately behind the front wheels, and their rear ends are supported by another bracket on the frame side member where it is cranked to pass over the banjo type rear axle. The lever arm of the torsion bar on each side is attached below the ends of the axle casing. A triangular link, the apex of which is rubber mounted on top of the banjo casing, laterally locates the rear axle. The circular section steel side components of this triangular bracket are pivoted in rubber bushes between lugs under a tubular frame cross member approximately below the heel board. The geometry of the system is such that the plane in which the triangular link is contained inclines upwards from the base of the frame cross member to the top of the axle casing. As the suspension rises, it exerts a restraining influence and progressively increases the rate of the spring. If all these links were equipped with solid bushes, this system would not function, but in fact the resilience



On the B.M.W. 501, torsion bar springs are employed and the A-bracket that laterally locates the axle is rubber mounted at all three joints and increases the suspension rate as the springs deflect upwards

of the torque arms under the axle tube and at all three points of the triangular link give it the flexibility necessary for its correct functioning. The bump stops are fitted underneath the frame side members and check straps, attached to the side members and passed round the axle, form the rebound stops.

Spax telescopic and lever type dampers incorporate Spaxamatic control discs. These discs are made of a composite material, the porosity of which is controlled during manufacture so that fluid can pass through them at a constant velocity. They operate in both directions and are self-cleaning during operation.

The telescopic damper incorporates a single pressure tube of heavy gauge steel and a bore of $1\frac{1}{8}$ in. Because of its large bore, the unit contains nearly 60 per cent more fluid than other contemporary types and operates at a low pressure. The piston is die cast and the control disc is incorporated in the piston during the die-casting operation. The piston rod tube is made of a high grade steel. It is centreless ground and plated with a hard chromium deposit. There are no spring-loaded valves or metallic moving parts in the displacement chamber, which is sited at the top of the unit beneath the mud-shield. Apart from the piston and rod, the only moving part in this damper is the recuperation valve. Spax telescopic units are charged with special hydraulic fluid in a manner ensuring complete evacuation of all air. They can be installed in any position. Spax, lever type shock absorbers also incorporate the Spaxamatic control disc and are interchangeable with many contemporary British units installed on motor vehicle suspensions.

FRONT SUSPENSION

No Major Changes

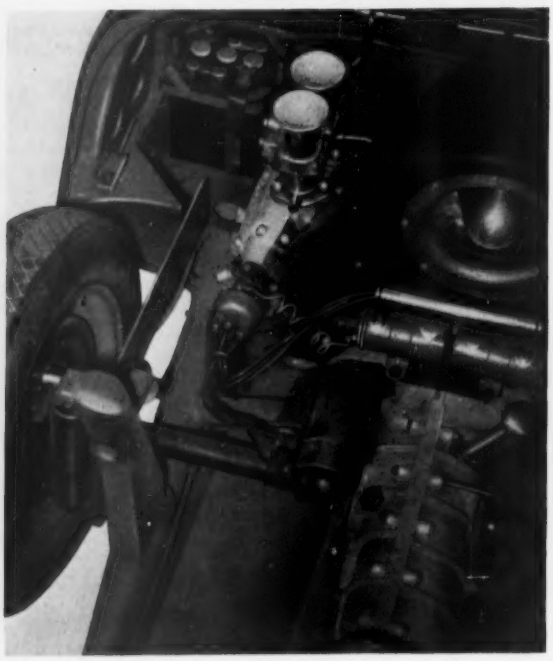
THE wishbone and coil spring type of front suspension has now reached such an advanced state of development that the majority of manufacturers employing this layout on new models have not departed from accepted practices. The same can be said about suspension systems incorporating torsion bar springs. Slightly greater wheel deflections are being adopted at the rear, so firmer front suspensions, particularly so far as roll stiffness is concerned, are generally employed.

On the new Austin Cambridge and Westminster saloons, the independent front suspension layout employed follows the well tried Austin lines with unequal length wishbones and coil springs. In both cars the whole of the front suspension unit is mounted on a detachable cross member which is secured to the chassisless body structure by taper seating bolts. Rubber blocks are interposed between the cross member and the body to prevent the transmission of road noise. The coil spring is compressed between the lower wishbone and an extension of the front cross member. This cross member also carries the rubber bearings of the lower wishbones. The upper wishbone arm is part of the Armstrong double-acting piston type damper assembly.

In the Lanchester Sprite, a separate front suspension unit is assembled on each side. Each assembly is individually bolted to the body-chassis structure. Pressed steel wishbones of unequal length are employed, their inner ends being rubber bushed. Girling telescopic dampers are housed within the coil springs. The upper spring-pan is in a deep flanged bracket extending between the arms of the upper wishbone. Bolted to this bracket is the plate that carries the upper end of the telescopic damper. This plate is assembled over a hole in the upper spring-pan, an arrangement that permits easy removal of the telescopic damper without disturbing the suspension spring. Ball type steering swivels are used and serve to accommodate both steering and wishbone movements. There is a single grease nipple at each point.

On the Wolseley Six-Ninety, the front independent suspension consists of upper wishbones, lower transverse links and torsion bars. The lower links are formed by a pressed channel section bolted to a forging. They have an effective length of approximately $13\frac{1}{4}$ in and the upper wishbones are

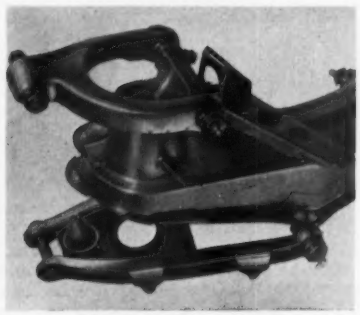
A welded fabricated upper wishbone link is employed on the Swallow Doretti



The trailing link in the Porsche Spyder 550 is made simply of steel strip

approximately two-thirds as long. The wishbones are two pressings bolted together at the outer ends to carry the pivot for the block in which is the upper bearing of the king pin. A drag strut takes the fore and aft loads on the lower link. This strut extends from its attachment point at the outer end of the lower link inwards and to the rear to a rubber bushed mounting on the chassis.

The torsion bars are attached to the inner ends of the forgings that are part of the lower suspension links, and extend diagonally backwards for a length of 4 ft 6 in to attachment brackets close together on the second cross member of the frame. Because of the inclination of the torsion bars relative to the longitudinal axis of the vehicle, it is necessary to incline the axes of the wishbone inner bearings so that the links trail slightly. The rear ends of the abutment brackets have screwed adjusters to allow the height of the front of the vehicle to be adjusted. The lower end of the



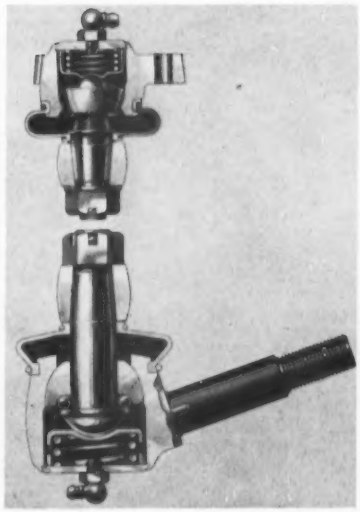
Hillman Minx front suspension unit

telescopic damper is attached to the lower suspension arm, and the upper end to a substantial bracket, which is part of the upper wishbone support.

On the Daimler 3½ and 4½ litre cars the familiar Girling type independent front suspension system is again employed. The lower links are box section pressings. They trail slightly and are pivoted almost at the centre of the front cross member of the chassis. The upper links are short forgings. In addition, substantial pressed steel radius arms react brake torque and also provide positive fore and aft location. The Newton telescopic shock absorbers are mounted coaxially with the coil springs, and forward of the suspension cross member is an anti-roll bar.

With certain exceptions, the independent front suspension of the Jaguar XK140 is basically identical with that fitted to the XK120 model. The suspension rate at the wheel is 154 lb/in; and the bump and rebound movements are 3⅛ and 3⅛ in respectively. An En 16T forging, rubber bushed at the inner end, forms the rear arm of the lower wishbone. A flange, which is serrated internally to receive the torsion bar, is spigoted into its rear face and secured by high tensile bolts. At the outer end of the arm there is a boss that is taper drilled and reamed to receive the En 24 suspension ball pin. The front arm of the wishbone is an En 3A forging with a rubber bush at its inner end. Secured to this arm are the lower end of the damper and the anti-roll bar bracket. The upper wishbone, which is an En 8Q forging, is rubber bushed at its inner end; its outer end carries the upper ball joint housing to which it is attached by two ⅜ in diameter, high tensile steel bolts. The ball joint housing is an En 8D forging. Its socket is induction hardened. A grease nipple is screwed into the spun-over top cover that retains the spring-loaded upper portion of the socket. The En 24 ball pin is induction hardened at its spherical end.

An En 16T forging, with a boss at the upper end to receive the ball pin taper, forms the vertical link of this suspension. Machined in the lower end of this link is the upper half of the spherical socket for the lower wishbone joint. The lower half of the socket is of Morganite, and is housed in a forged cover spigoted to the underside of the vertical link and secured by four ⅜ in diameter high tensile set screws locked by tab washers. Shims, inserted between the cover and link, control the end float of

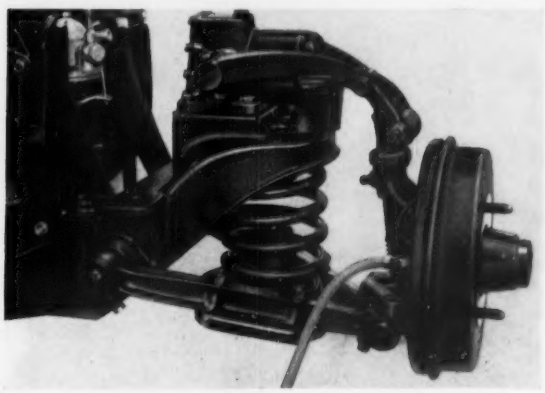


Sectional view of the Thompson upper and lower suspension joints

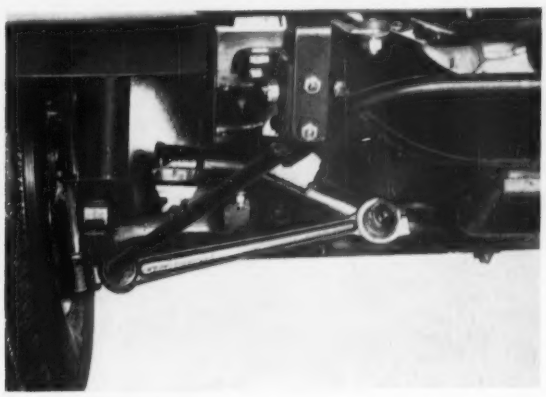
the ball pin. A boss at the centre of the vertical link is machined to receive the tapered En 16T stub axle, which is pulled up by a ¾ in slotted nut locked by a split pin.

Special precautions are taken to seal the lower ball joint against the entry of water and dirt. The upper end of the rubber gaiter employed is nipped between a retainer plate, fitting round the ball pin taper, and the lower face of the wishbone boss. It is also clamped by a spring steel wire circlip to a lipped plate secured to the vertical link by four self-tapping screws. The ¾ in diameter anti-roll bar is carried in rubber blocks bolted to the underside of the frame and its ends are connected by forged links to the anchorage brackets on the lower wishbones. A pair of rubber washers at the upper ends of the links and a rubber bearing at the lower ends accommodate the relative motion between the bar and wishbone.

On the Aston Martin DB3S competition car, the trailing link front suspension is basically the same as

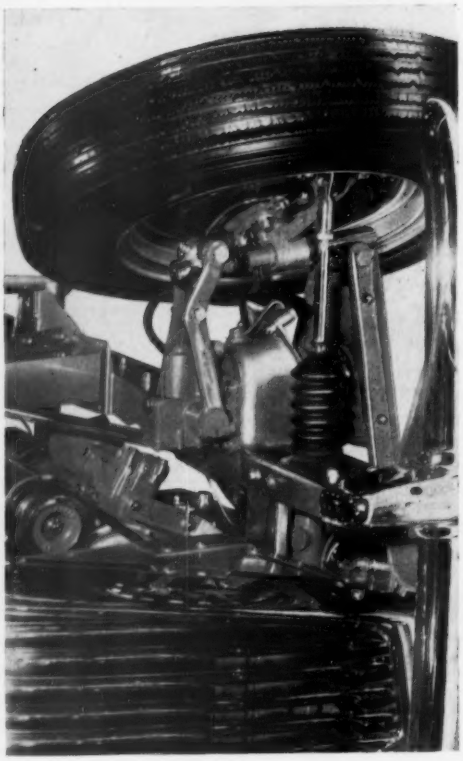


Armstrong GS5-IS9/10 shock absorber unit on the Austin Cambridge suspension



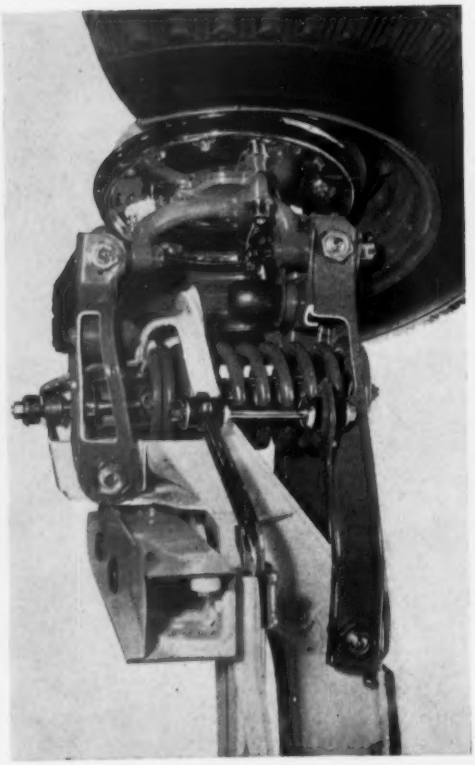
The suspension system on the Vedette 55 is similar to that of the British Ford models

A simple but light structure carries the suspension on the Morgan chassis



In the M.G. TF, the shock absorber levers form the upper wishbone arms

The Morgan suspension system remains unchanged



An anti-roll bar is employed at the front of the Vauxhall Cresta

that which was employed on the DB3 model. The two transverse torsion bars extend almost the full width of the frame. Since the axes of the lower link bearings on each side are in line, the torsion bars are set at an angle to the axis of rotation of the suspension links. This arrangement is effected by inserting the splined outer ends of the torsion bars into blocks that are of square cross section, but the faces of which are curved as viewed on a longitudinal section. These blocks fit into a plain square section socket in a boss at the pivot-end of the link.

The new Thompson suspension joints are intended for accommodating front suspension link and steering motions at one point. These new joints have the advantage of a free turning action in the load-carrying lower socket, in addition to aiding in the reduction of unsprung weight. They also permit, in specific cases, an improved layout in suspension design. From the maintenance angle, the use of these joints reduces the lubrication points from approximately five to two, and several costly operations are eliminated when a complete overhaul of the suspension becomes necessary.

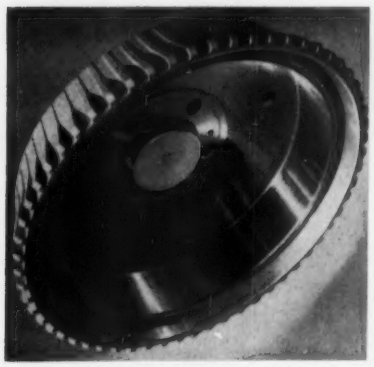
In the front suspension of the Buick Series 61, the wheels are independently mounted on the front cross member of the frame. Each assembly comprises a steering knuckle, a steering knuckle forging, a lower wishbone assembly, and a coil spring. There is a large rubber bump stop on the outer end of each lower wishbone and a similar rubber rebound stop mounted on the chassis frame under each upper transverse link. A spring steel anti-roll bar is employed. It is carried in rubber bushes in brackets attached to the lower flange of each frame side member. The ends of the bar are connected to the lower wishbone assemblies by vertical links, in the ends of which are rubber grommets.

The lower wishbone assembly comprises two drop-forged steel arms riveted to a stamped steel spring pan. A small plate riveted above the spring pan serves as a mounting for a rubber bump stop and for one end of the vertical link to the anti-roll bar link. Hardened steel, threaded bushes are screwed into the inner ends of the forged arms. The steering knuckle forging is connected to the lower wishbone assembly by a large, threaded pivot pin secured by a nut and lock washer. A hardened steel bush of the threaded type is screwed into the lower end of each knuckle forging to carry the pivot pin in the outer end of the lower wishbone assembly. A threaded pivot pin for the upper transverse link is clamped eccentrically in the upper end of the forging. This eccentric pin is adjustable for camber and castor. The hardened steel king pin operates in bronze bushes and is located in the forging by a tapered pin. Vertical thrust is taken by a ball bearing between the steering knuckle and the forging.

BRAKES

Increased Adoption of Servo Assistance: Disc Brake in Production

CHANGES in the designs of brakes for private and racing cars during the past twelve months have been mainly in the nature of detail modifications. This applies to foreign as well as British vehicles. Considered generally, the braking efficiency of the small and medium-size cars meets normal requirements satisfactorily, and it is chiefly in the larger and higher-speed classes that improvement may be needed. In some, better braking has been obtained by increasing the area of friction linings by enlargement of drum diameter or shoe width. Progress has also been made by brake lining manufacturers in the production of materials less liable to fading and squeal, though the problems that these defects present are still receiving attention and await complete solution.



In the new Wellworthy Al-Fin bi-metallic brake drum, the cast iron liner is molecularly bonded and the fins are arranged radially instead of circumferentially

Hydraulic operation is now provided almost universally, and in the majority of cases, two leading shoes are applied to front wheel drums and leading and trailing shoes to those on the rear wheels. A noticeable development is the more widespread provision of vacuum servo assistance, particularly for the brakes of the larger and faster cars. In a number of brake installations advantage is taken of the increased application pressure thus obtained and two trailing shoes are fitted at the front to ensure greater stability.

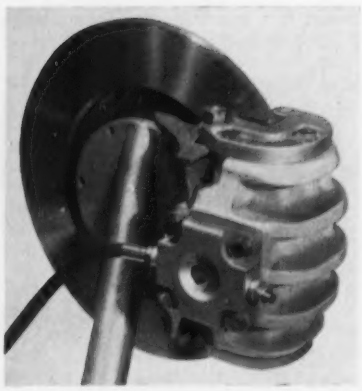
Bentley

A departure from vacuum servo assistance is seen on the Bentley Mk VI chassis, on which use is made of a friction servo of the disc type driven from the gearbox. This is brought into operation by the brake pedal and takes effect only on the hydraulically applied front wheel brakes. Those at the rear are actuated mechanically and are thus unaffected should the front brakes fail. On the Buick Century an electrically driven booster pump is included in the brake vacuum servo equipment. This operates to exhaust the vacuum reservoir when the engine is switched on and cuts out when it starts up.

Al-Fin

For racing and other high-speed cars the combined advantages of better heat dissipation and reduction of weight are obtained by the use of bi-metallic brake drums, having external fins, either transverse or peripheral, which also add rigidity. A new type of bi-metallic drum, shown for the first time by Wellworthy Ltd., and fitted to the Austin-Healey 100S, Triumph TR2 and Bristol 405 cars, consists of a comparatively thin cast iron liner around which is cast the light alloy drum to which it is molecularly bonded by the well-known Al-Fin process in the foundry stage. As compared with shrink fitting, this bonding method ensures better heat conductivity between the liner and drum. It is also said to effect a saving in weight of up to 40 per cent. The external surface of the drum is cast with fairly closely spaced transverse ribs or fins, about $\frac{1}{4}$ in wide, which are considerably deeper at their inner ends in order to afford greater resistance to bell-mouthing. With these transverse, or radial, ribs the cooling

The Dunlop disc brake can be applied hydraulically or mechanically to the rear wheels of the new Austin-Healey 100S



Model of the hydraulically actuated Lockheed front wheel disc brake mounted on a display stand

effect is considerably greater than with peripheral fins.

Transversely arranged fins, about 1¼ in deep, are cast on the wide turbo-cooled brake drums of the 300 SL Mercedes Benz, which has a maximum speed of over 150 m.p.h. On the front wheel drums of the Alfa Romeo cars exhibited, the fins are set at an angle of 30 degrees, so that rotation has the effect of directing the air outwards through apertures in the wheel discs. Peripheral fins are cast on the rear wheel drums.

Disc brakes

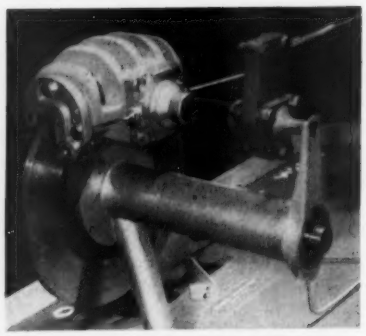
Those who expected to find at this year's show evidence of a much wider acceptance of the disc brake than was the case last year will have been disappointed at its representation on only two exhibited cars in addition to the model forms on gallery stands. Interest and belief in its possibilities, as applied to the larger and faster types of car at least, may, however, be said to be well sustained. That it has made important progress is shown by the fact that the Dunlop disc brake, as fitted to the Jaguar D type and Austin-Healey 100S cars, and the Girling type have reached the production stage.

That fitted to the Jaguar is of the type having three round friction pads applied hydraulically to both sides of the disc. A more compact assembly of later design is used on the Austin-Healey and is applied without servo assistance. Two single segmental pads are carried in a comparatively small, light alloy calliper, one on each side of the disc. The two hydraulic cylinder housings are each secured to the outer faces of the calliper by four bolts which pass through bosses that form the only points of contact through which heat can be conducted, and the resultant air gap between the two adjoining faces also assists cooling. A hydraulic balancing tube connecting the two cylinders ensures equal application pressure on the two sides of the disc.

Additional round friction pads are applied to the rear wheel discs by hand lever and connecting cables. These are carried on each side of the disc by two steel plates hinged to the calliper. The operating lever, to one end of which the cable is attached, has its other end pivoted to a lug on the outer end of the plate on the inner side of the disc. A bolt is pivoted to the operating lever and passes through

Cut-away illustration of the Clayton Dewandre concentric brake servo cylinder showing the toggle levers by which a reactionary effect against the pedal pressure is produced

a clearance hole in the inner plate and through the outer plate in which it is held by an adjusting nut. Thus, when the operating lever is pulled inwards by the cable, the levers are drawn together, squeezing the disc between the pads with equal pressure on the two sides.

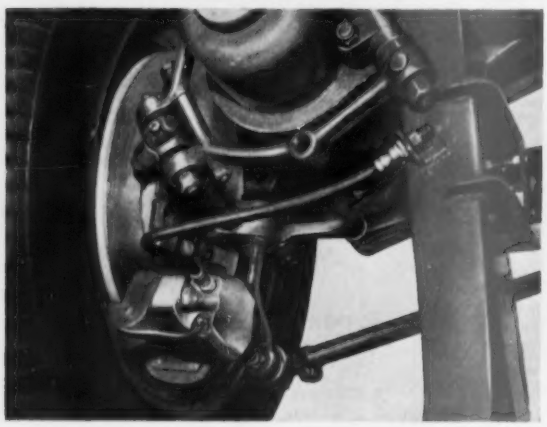


The Lockheed rear wheel disc brake can be applied either by a hydraulic cylinder or by hand lever through a cable control

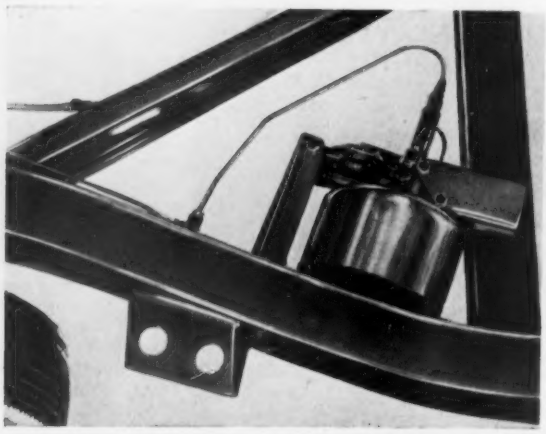
As exhibited, the Lockheed front and rear disc brakes are unchanged from those shown last year, while the Girling hydrostatic brake was shown in its improved form, similar to that applied to the buses of the Birmingham and Midland Motor Omnibus Co. Ltd. The segmental friction pads are thicker than those of the earlier version and are mounted on metal plates, and the pressure from the hydraulic cylinders is applied through metal cone inserts, the apices of which bear on very small areas of contact on the pad mountings. As a result of these changes, it is stated that vaporization of the hydraulic fluid due to the transmission of heat has been eliminated.

Clayton Dewandre

A development of importance in view of the increasing adoption of vacuum servo assistance for hydraulic brakes is the introduction of servo and slave cylinders combined to form one compact unit, thus saving weight and facilitating installation in the chassis. In its latest form the Clayton Dewandre Concentric servo, the prototype of which appeared at last year's motor show, is of extremely simple design. The vacuum servo cylinder is combined in axial alignment with either a Girling or Lockheed slave



This example of front wheel application of a hydraulic disc brake was shown on a mock-up on the stand of Girling Ltd.



The Lockheed Hydrovac brake servo unit is mounted towards the rear end of the frame on the Riley Pathfinder chassis

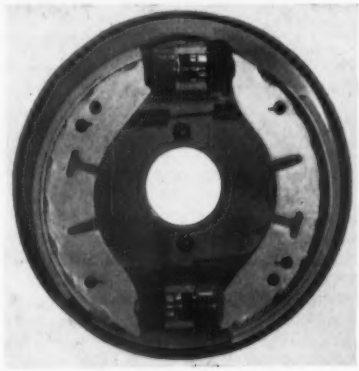
cylinder. The servo piston rod has direct connection to the brake pedal and directly operates the slave cylinder plunger when the pedal is depressed. Its movement first closes a valve, shutting off the vacuum cylinder from the atmosphere. Further movement opens the vacuum valve so that the servo piston is drawn up the cylinder against the action of a return spring, to assist the pedal effort on the slave cylinder plunger. Two toggle levers, with their inner ends engaging a concentric sleeve, are carried on a casting abutting the vacuum side of the piston. Through these levers, application effort exerted by the piston creates a reaction which is transmitted through the rod connection to the brake pedal. In the event of vacuum failure there is, of course, a complete lack of servo assistance, but brake application can still be effected by direct human effort.

Lockheed

The new Lockheed Hydrovac servo unit is used in conjunction with a normal Lockheed master cylinder to which it has pipe line connection. It consists mainly of a vacuum servo cylinder and hydraulic slave cylinder in axial alignment, with the vacuum piston rod actuating the slave cylinder plunger. In the released condition both sides of the vacuum piston are subject to atmospheric pressure. When an effort is applied to the brake pedal, the fluid pressure thus generated actuates a control valve in the Hydrovac unit, causing a proportionate degree of vacuum to be created in the cylinder behind the piston. In consequence, a thrust is applied to the slave cylinder plunger, additional to the master cylinder pressure. These two forces combine to generate the pressure applied by the slave cylinder to the wheel cylinders. A valve device is incorporated within the slave cylinder plunger to provide direct communication between the master cylinder and wheel cylinders should, for any reason, the Hydrovac fail to operate.

Brake shoe adjusters of the automatic type do not appear to be in such demand as might have been expected, particularly from car owners unwilling or unable to attend to their brake requirements and dependent upon local garage assistance for this service. That such adjusters need not add considerably to the complication of brake application mechanism is illustrated by the new designs introduced by the Lockheed Hydraulic Brake Co. Ltd., Leamington.

One of these was shown applied to an 8 in front wheel brake having two leading shoes and applied by a hydraulic piston. Two metal friction segments, in a groove cut round the piston, are held in contact with the hydraulic cylinder wall by a coil spring contained in a diametral hole through the piston. On brake application the segments are moved along the cylinder bore by one face of the groove, and when the brake is released, the tension of the pull-off spring is insufficient to move the segments from the position to which they were pushed. But as the groove is slightly wider than the segments, the necessary clearance between the shoe lining and drum is provided for and is maintained constant by slightly extended movements of the segments as wear occurs during service.



Lockheed automatic adjusters fitted to the two leading shoes of an 8 in front wheel brake and partly sectioned

Shoe adjuster

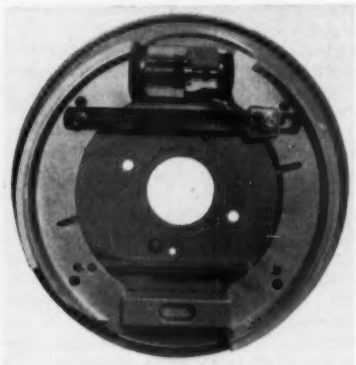
Another Lockheed adjuster was seen applied to an 11 in rear wheel brake fitted with leading and trailing shoes. In this case automatic adjustment depends upon the action of an operating bar. One end of the bar is mounted on a pin on the web of one brake shoe close to the hydraulic cylinder, and the other end, by means of a spring, is held in engagement with the teeth of a ratchet wheel mounted on the other shoe and integral with a cam interposed between the shoe and the hydraulic piston. When the brake is applied, the ratchet wheel is held stationary by a pawl. If, on release of the brake, and owing to lining wear, the travel between the wheel and operating bar is sufficient for the latter to reach the next tooth of the ratchet, the cam will be turned appropriately to maintain the required clearance. To centralize the shoes in the drum, the hydraulic cylinder is free to slide in its mounting on the backplate and an elongated hole permits slight sliding movement of the operating bar on its pin mounting on the shoe.

A new Lockheed hydraulic brake cylinder is designed to equalize the lining wear of leading and trailing shoes, thus eliminating an inherent defect of this widely used type of brake shoe assembly. The cylinder has a stepped bore with pistons of different diameters, the larger one exerting a greater proportion of the application pressure on the trailing shoe.

Controls

There are still wide differences of opinion as to the best position for the hand brake lever or handle. On the majority of cars a pull-handle is located below the dash where it is unobstructive though not so conveniently within reach as a horizontal hand lever at floor level on the right- or left-hand side of the driver's seat. In some cases, for example, on the Austin Cambridge and Westminster and Studebaker cars, a pull-on handle is carried on the steering column, or below the dash close to the column as on the Lagonda, Peugeot and Nash Ambassador vehicles. An unusual position is selected for the brake control on the Panhard Dyna Junior, which has a pull-on handle on the facia board close to the driver's right hand on the steering wheel. A new position for the Rover 75 and 90 models is just forward of the offside front door opening.

A useful hand brake refinement on the Lagonda 1955 and Armstrong-Siddeley Sapphire is a warning lamp which lights up when the brake is applied. Of even greater safety value is the warning lamp fitted to the 4½ litre Daimler which tells the driver when the depression in the vacuum reservoir is down to zero.



In the Lockheed brake cylinders shouldered pistons are employed to equalize wear on leading and trailing shoes

A rear wheel brake with leading and trailing shoes fitted with the new Lockheed ratchet-type automatic adjuster

STEERING

Recently Introduced Power Assisted Steering Units for Cars

SO far as overall efficiency and other design features are concerned, there seems to be little scope for further improvement of steering gear units. However, there is a certain demand for power or power-assisted steering for larger cars. This demand comes mainly from the export markets, where some customers have developed a preference for the light handling characteristics of the large American cars equipped with power steering. Several American manufacturers exhibited cars equipped with power steering.

Girling Ltd. have developed a power-assisted steering unit, which was exhibited on an Armstrong Siddeley Sapphire chassis. Connected to the mechanical linkage of the steering system is a valve mechanism. This is actuated by the normal steering movement and controls the flow of fluid under pressure to a hydraulic ram, or motor, which assists the driver.

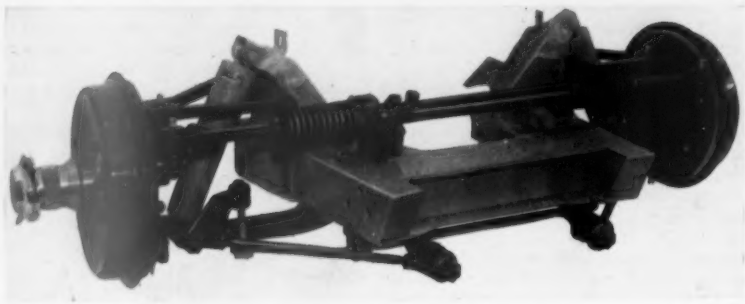
The output of this hydraulic ram or motor is proportional to the manual effort applied to the steering wheel. To obtain this effect, a powerful centring spring is interposed between the valve and the steering ball joint which connects the unit to the steering linkage; the force of this spring must be overcome before the hydraulic mechanism is brought into use. Ample space has been left to allow springs of various strengths to be fitted. In general it is expected that the strength of spring should be such that the effort required at the rim of the steering wheel is about 3 to 5 lb.

Directly connected to the socket carrying the operating ball is the valve bobbin, so arranged that immediately it is displaced from its central position, there is a gradual build-up of pressure on one side of the valve, whilst the fluid on the opposite side exhausts at an increasing rate. Special attention has been paid to obtaining the smallest possible displacement of the valve. A semi-flexible coupling connects the valve bobbin to the ball assembly. This avoids the necessity for accurate alignment between the two parts. Also, as the valve is a closer fit in its housing than the ball assembly is in its socket, the semi-flexible coupling ensures that the valve bobbin does not react the load applied to the steering ball. The valve mechanism of this telescopic type unit, wherein the valve is directly connected to the operating strut, is generally similar to the valve construction employed for a system using a rotary type of actuating motor.

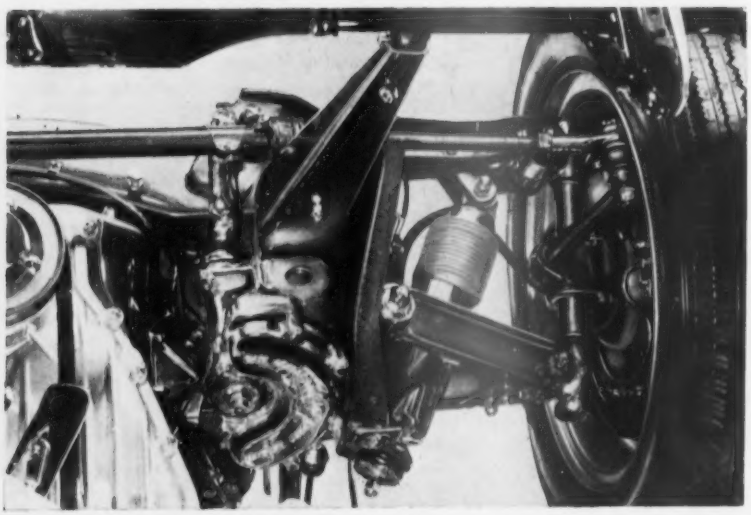
Some independent front suspensions are not suited to the incorporation of telescopic power-assisted steering mechanisms, in that no single rod takes the entire load. However, such layouts usually include an idler lever assembly on the opposite side of the chassis to the steering box and in these cases it is possible to replace the idler by a rotary hydraulic motor, with the actuating valve built into some part of the steering box or attached to the drop arm. The Girling hydraulic motor takes the form of a double vane type pump designed to give the same power output as the telescopic unit. The layout is such that the oil seal is not under high pressure but is vented back into the low pressure or exhaust side to avoid high friction from tight seals.

Both systems are fed by an engine driven Gerotor type pump fitted with a flow control valve, which limits variation of flow with speed, a self-contained filter and a reservoir. The speed range of the pump is between 600 and 6,000 r.p.m. and the maximum output is approximately 1¼ gal/min. Full working pressure is 600 lb/in^2 and is obtained at a pump speed of 900 r.p.m. The fluid employed in the system is S.A.E. 10W engine oil.

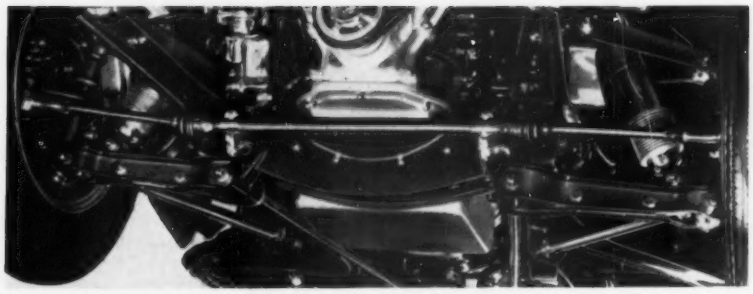
On the Jaguar XK140, the pinion housing of the rack and pinion steering is a malleable iron casting bored to receive an eccentric mild steel sleeve in which the En 36T pinion is carried in two Torrington needle roller bearings of 1⅛ in inside diameter. External serrations formed at one end of the sleeve engage in a plate bolted to the rear of the housing. Rotation of the eccentric sleeve during assembly allows the required depth of mesh between the teeth of the pinion and the rack to be obtained. The helix angle of the teeth on the En 30B rack is 25 deg, and the centre seven teeth are flame hardened. For axial location of the pinion there is at the front of the housing a hardened thrust plate that registers in an annular recess in the pinion. A key-hole slot is machined in the plate to facilitate assembly. To make a grease seal between the pinion and the housing, a rubber ring is retained between two pressings bolted to the rear of the housing.



On the frame of the Jaguar XK140, the brackets that carry the rack and pinion steering mechanism are specially designed to minimize the transmission of road noise through the frame to the body



A three-piece track rod steering layout is employed on the Riley Pathfinder, and the suspension shock absorbers are finned to keep working temperatures to a reasonably low level



The three-piece track rod steering layout of the Riley Pathfinder is exceptionally rigid and should give good handling characteristics

Support for the rack on the side remote from the pinion housing is provided by a tube with a butt-welded flange. It is bolted to the pinion housing, and inserted at its extremity is a bronze bush in which the rack slides. A tapped hole at each end of the rack receives the inner ball joint for the tie rod. This ball joint is locked to the rack by a tab washer and sealed by a large rubber gaiter which expands and contracts as the rack moves. Adjustment of the tie rod length is made at the outer ball joint, attached to the steering arm. Lubrication of the assembly is effected through a grease nipple on the housing.

The whole unit is flexibly mounted on the chassis by a pair of brackets incorporating metal-to-metal bonded blocks. One bracket is below the pinion housing and the other is at the extremity of the rack support tube. A bronze plunger, loaded to 50 lb by a coil spring and mounted at the inner end of the support tube, bears on the upper surface of the rack. Its function, in conjunction with the flexible mountings, is to damp out movement due to road wheel reactions. The pinion is connected to the steering column by a universal joint. The pitch circle diameter of the pinion is $\frac{7}{8}$ in and the rotation of the pinion from lock to lock is $3\frac{3}{4}$ revolutions. On full lock the wheel angles are $34\frac{1}{2}$ deg and 38 deg.

Another example of rack and pinion steering was shown in the Aston Martin DB3S competition car. The unit is mounted slightly behind and below the front cross member of the frame. This layout, with steering levers attached to the outer ends of the two-piece track rod, is almost identical with that employed in the DB3 model. However, two universal joints are now fitted to the steering column to transmit the motion from the steering wheel to the rack and pinion unit.

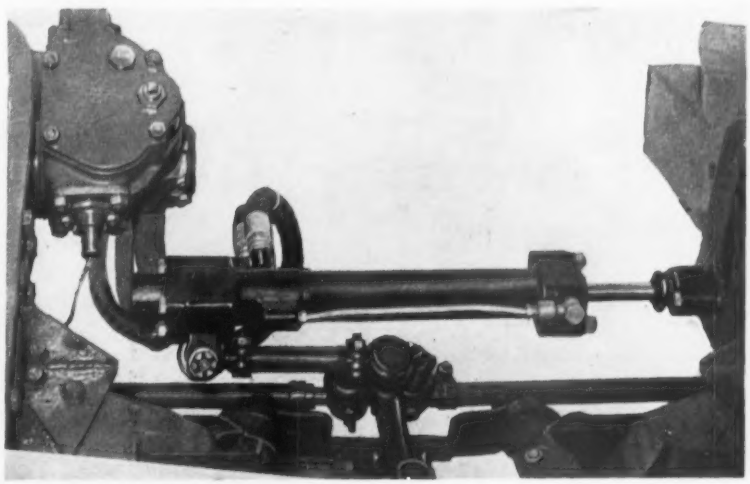
In the new $3\frac{1}{2}$ and $4\frac{1}{2}$ litre Daimlers, a Marles cam and roller steering gear is employed. The steering box is mounted forward of the main suspension cross member, and is fitted with a telescopic column. A link connects the drop arm to a centrally pivoted lever. Attached to the opposite ends of this lever are both sections of the divided track rod, which are behind the cross member. All the steering links and front suspension joints, with the exception of a single nipple on each upper wishbone, are connected to a central lubrication system of the automatic thermal type. The circulating unit is close to the exhaust pipe so that, as it cools, lubricant is drawn from the reservoir and then, as it warms up again, expands and is delivered to the various points.

A cam gear type steering unit with a ratio of 16:1 is employed in the Austin Cambridge and Westminster saloons. The three-piece track rod and the entire steering layout in both cars are similar to those of the earlier Austin models. The dimensions of the individual components of the steering gear are different in both cars.

The Girling rotary type power assisted steering unit is for use in layouts incorporating centrally pivoted levers

The recirculating ball, worm and nut type manual steering gear of the Buick Series 61 has a ratio of 23·6:1. When the car has power-assisted steering, the ratio is 21·3:1. In both types of steering gear, two sets of 30 balls are used, each set operating independently of the other. The teeth on the nut that mesh with teeth on a segment formed integrally with the drop arm shaft are so arranged that they mesh more tightly when the front wheels are in the straight ahead position than when they are at full lock. The teeth of the segment are slightly tapered so that backlash may be set by moving the drop arm shaft endways by means of an adjuster screw that extends through the end cover of the housing. The drop arm spindle is carried in two bronze bushes in the side cover of the housing. Two spherical roller thrust bearings, which bear against spherical seats on the ends of the worm, carry the lower end of the steering shaft; the outer race of the upper thrust bearing is pressed into the steering box. At the upper end of the steering shaft, support is afforded by a ball bearing mounted in the top end of the steering column tube. The left end of the intermediate rod is carried by the steering drop arm and the right end by an idler arm which pivots on a support mounted on the frame. The ball studs are riveted to the side rods, drop arm and idler arm, and seat between pairs of ball sockets contained in the end fittings on the intermediate rod. The openings through which the ball studs enter the intermediate rod are protected by pressed steel dust covers.

The power steering gear assembly, which is an optional fitting on Buick Series 61 cars, consists essentially of a vane type oil pump, which is belt driven from the engine crankshaft, a reservoir, a flow and pressure valve unit and the power cylinder attached directly to the special steering gear housing. An



The Girling power steering assembly for the larger private cars. At one end, the hydraulic ram is secured to a bracket on the frame, and at the other, the valve unit is attached to the steering linkage

extended drop arm spindle carries a gear segment which meshes with the power rack pinned to the piston end of the power cylinder. Flow to the double-acting power cylinder is controlled by a hydraulic valve unit, also incorporated in the steering gear case. Essentially, this unit comprises five equally spaced pairs of plungers kept apart by a heavy coil spring. The oil flow is regulated by the sliding of a double grooved valve spool. This spool is mounted concentrically with the worm shaft and is between the worm thrust bearings, so that the whole assembly moves together as one unit. The steering effort required is between 4-9 lb at the wheel rim. The flow valve of the vane type oil pump starts to open at 300 to 400 r.p.m. of the pump and so is functioning properly when the pump is idling at 465 r.p.m., which corresponds to an engine speed of 450 r.p.m. Minimum flow, approximately ¼ gal/min, is produced at 465 r.p.m. and the pressure is 700 lb/in². The flow valve permits a maximum flow of approximately 1¼ gal/min at 2,000 r.p.m., when the pressure is 50 lb/in². At a pressure of 750-900 lb/in², the pressure relief valve blows off. The hydraulic system has a capacity of 3 pints of Dynaflow Drive hydraulic fluid; other fluids must not be used.

On the latest Chrysler New Yorker model, all the components of the power steering gear are fitted into an elongated tubular housing and are concentric with the axis of the steering column. Because of its slender shape, this power steering unit is exceptionally good, from the space utilization point of view. The motion of the steering shaft is transmitted to a worm gear, and a small roller gear meshes at right angles to the worm and actuates a drop arm, which is connected directly to the steering linkage. This unit incorporates, therefore, two basic mechanisms: a worm and nut with recirculating balls and a rack and segment gear. Fastened to the worm nut, in succession, are an upper piston rod, a piston and a lower piston rod, all concentric with the steering column axis. The lower piston rod terminates in the rack gear mentioned above which meshes with the gear segment that is part of the drop arm. A conventional steering linkage arrangement is employed in conjunction with a wishbone type of independent suspension.

The hydraulic control system consists of a double acting piston, a spool valve fitted inside the piston, and a hydraulic reaction chamber, which enables the driver to obtain the feel of the road. A flow valve directs high pressure oil to one side or the other of the double-acting piston. At the same time, valve movement opens an oil return circuit that carries oil from the low pressure side of the piston to the oil reservoir. Depending on the direction of steering wheel rotation, the direction of oil flow is such that the hydraulic force is added to the driver's effort and is transmitted through the lower piston rod-cum-gear rack to the segment and to the steering gear arm. Other components of the hydraulic system are an oil pump, complete with pressure relief valve, a flow control valve and a filter for the oil reservoir. The pump is coupled direct to an extension of the dynamo shaft. The flow control valve limits the oil flow to a maximum of 1½ gal/min and ensures that the power required to drive the oil pump is a minimum. Two flexible hoses connect the power steering unit and the oil pump unit.

Maximum pressure build-up in the system is limited to 800 lb/in² by the relief valve in the pump unit. The hydraulic system holds four pints of oil which normally is S.A.E. 10W engine oil. If the vehicle has to operate in extremely high temperatures, S.A.E. 30 oil is employed. The effort on the steering wheel rim is between 4 and 7 lb, and the steering gear ratio is 16·2 : 1.

FRAMES AND CHASSISLESS CONSTRUCTION

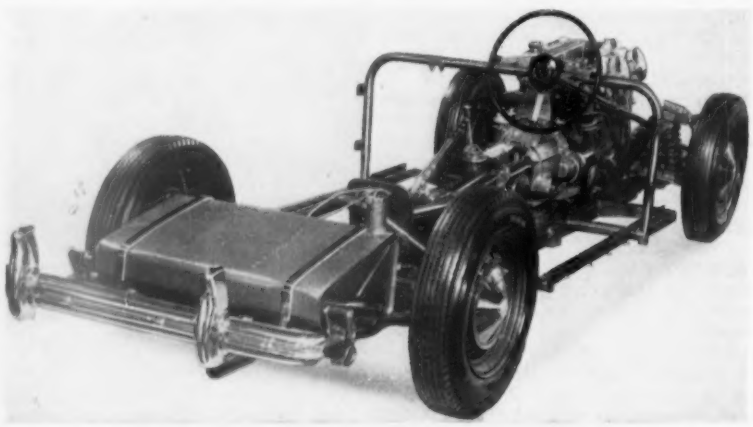
Most Manufacturers of Quantity Produced Cars Now Adopt Chassisless Construction

Of the thirteen British saloon and sports car models that appeared for the first time at Earls Court, only five have an entirely separate frame on which the body is mounted. One of the chassisless vehicles, the Jaguar D type, is of semi-monocoque construction, and the other seven are of an integral construction in which a pressed steel underframe forms the basis of the vehicle. Of the five types based on a separate frame, the Daimler Regency and Regina have cruciform braced chassis, as has been this manufacturer's practice for many years.

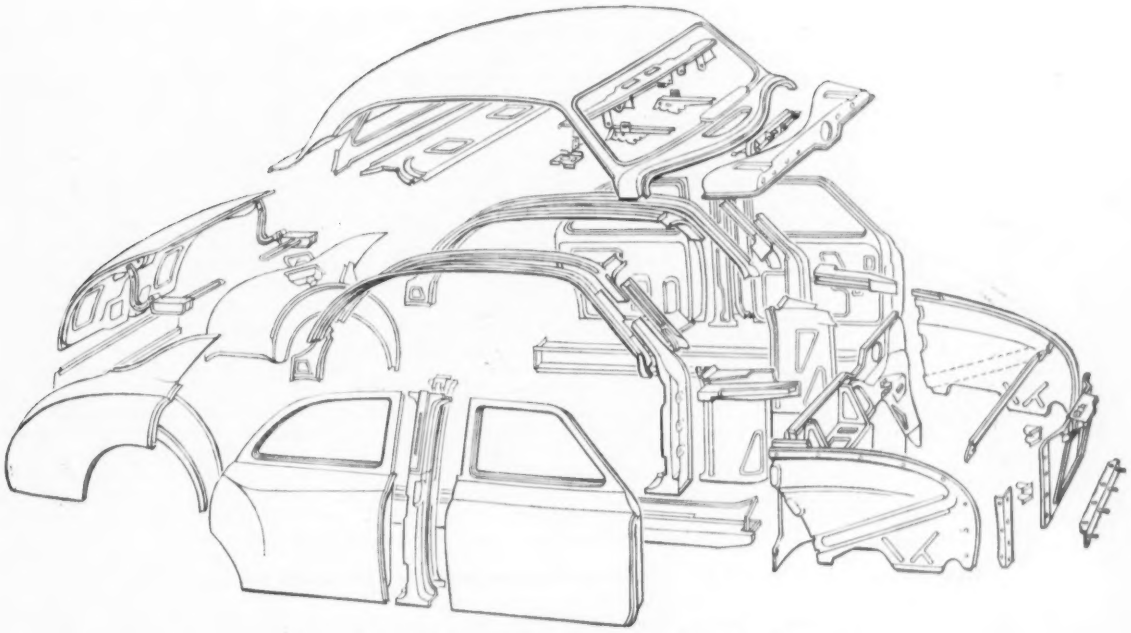
The main difference between the Regency and Regina models is in the wheelbase, that of the Regency being 9 ft 6 in and that of the Regina 10 ft 10 in. Both have a box section frame, with side members parallel for most of their length and swept in at the front to provide the necessary clearance for the wheels. An additional side member, inboard of the main side members, extends forwards from the front ends of the cruciform bracing, and the coil spring housing is welded across the two. At the rear, the frame is sharply upswept to clear the axle, and the mounting for the rear telescopic dampers is welded at the highest point of the frame. Outrigger brackets are welded along the outside of the frame to receive the body mountings, and tubular cross members stiffen the frame on the upswept rear section. The front cross member is a slightly dished pressing and incorporates the brackets for the pivots of the lower arm of the suspension. Immediately above this, on the inner front main member, is welded a bracket to which the engine mountings are bolted.

The Wolseley Six-Ninety frame is similar in most details to that of the Riley Pathfinder. The side members are of box section, parallel between the wheel arches, and swept in slightly at the rear. They are also swept in at the front, but to a much greater degree, and the frame width there is less than half the width of the centre portion of the chassis.

To avoid loss of rigidity where the frame sweeps inwards at the front, longitudinal bracing members of deep channel section are introduced. They extend rearwards from the front main cross member to points close together



On the Swallow Doretti, a tubular frame suitable for production in relatively small numbers is employed



The principal components of the body structure of the M.G. Magnette

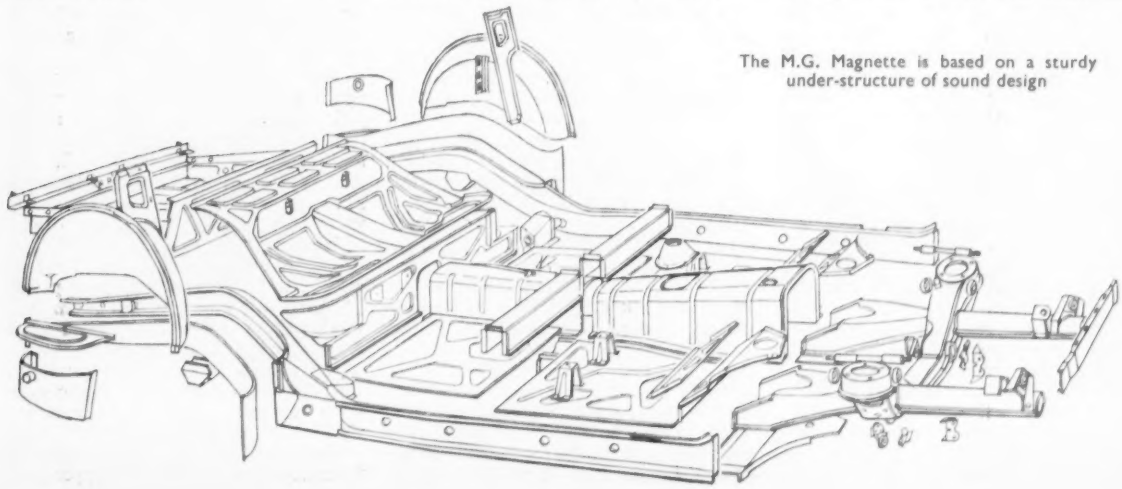
on each side of the second cross member. Thus they form, in effect, the forward arms of a cruciform structure. The third cross member is cranked to pass under the propeller shaft. This third cross member carries pressed brackets to which are attached the forward ends of the two radius rods used in the coil spring rear suspension. Another cross member, but of tubular section, is welded across the frame between the rear spring pans, which are formed in the side member pressings. Behind the left-hand spring housings a bracket is provided for the Panhard rod. The rearmost cross member is a simple channel section pressing.

A simple, triangular pressing is welded on top of each main side member at the front to carry the front pivots of the upper wishbone, and to house the upper end of the telescopic shock absorber.

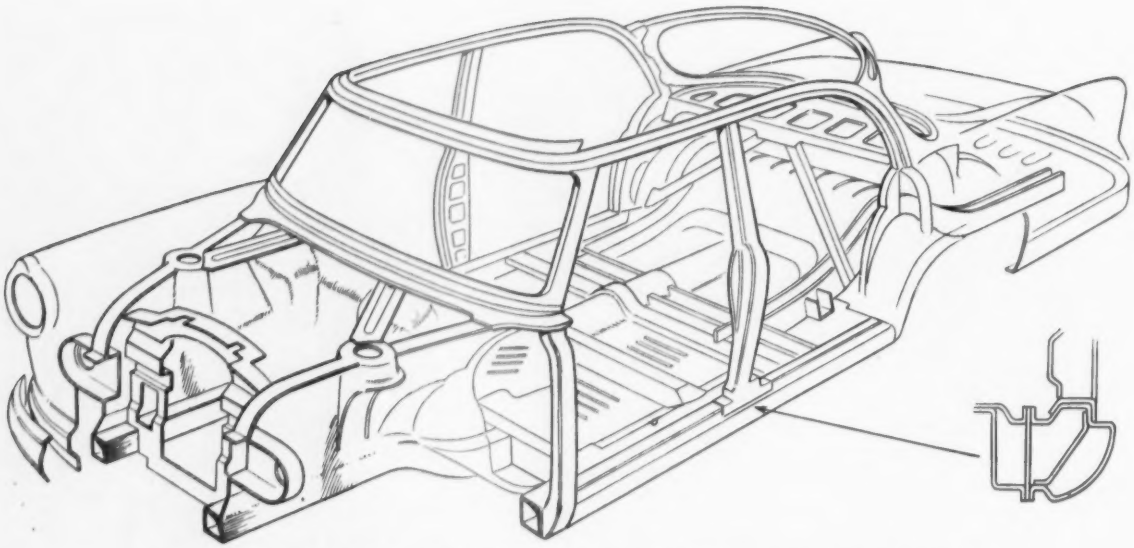
Although the Humber Hawk chassis has been in production for a number of years, the version shown at Earls Court has been subjected to considerable development. The frame consists of channel section side members and a cruciform bracing with holes punched in it for lightness. The coil type front springs are carried in housings formed in the frame, the upper wishbones being pivoted on a bracket welded to the top of the side members. The second cross member, on which are welded the rear engine mountings, instead of being welded to the side members in the conventional manner, is insulated from the frame by rubber blocks; the engine mountings are also insulated from the cross member in the same way.

A chassis frame of tubular construction is used in the Swallow Doretti two-seat sports car. This is a straight-forward design with several noteworthy features. The main side members are made of 3 in diameter, 50 ton, chrome-molybdenum-steel tube. They are parallel throughout their length and are stiffened by channel section pressings welded on top and below the tubes from a point immediately behind the front suspension units to behind the rear axle. Tubular and channel section outriggers are welded to the main side members to carry the floor and body. The front tubular cross member is attached at its outer ends to a rectangular scuttle framing, also formed of steel tube, and there is a diagonal tubular brace on the side on which the steering column is situated.

The sill rail consists of an angle section welded on top of the outriggers, and the frame is completed by tubular cross members, one in front of the engine, which is set well back, one



The M.G. Magnette is based on a sturdy under-structure of sound design



From this sketch, an impression can be gained of the general layout of the structure in the Vedette 55

behind it in the centre of the frame, and the third between the front mountings for the rear springs. Two parallel bracing members extend between the second and third cross members. Carried on the third cross member are the brackets for the tie rods that locate the rear axle. Further stiffness is conferred on the structure by the use of a large section cranked tube between the two piston type rear shock absorbers.

Exceptional stiffness, combined with extremely low weight, is obtained in the semi-monocoque structure of the D-type Jaguar sports-racing car. Magnesium alloy is largely used in the structure, which is assembled mainly by riveting and welding. This structure comprises a framework of square-section tubing, with stressed bulkheads and stressed outer panels with fabricated stiffening members.

The centre portion of the body, between the two bulkheads, contains the driver's and passengers' seats. A triangulated framework of square section tubes extends diagonally forward from a point on the rear bulkhead above the propeller shaft aperture. This framework passes on each side of the engine and is welded to the front cross member; two further square section tubes run forward from the outer edges of the front bulkhead diagonally to pass under the front of the engine. These too are welded to the centre of the front cross member, which is also a triangulated girder structure.

Where the additional tubes meet the upper main framing, they are welded to them, so adding further torsional rigidity. Stiffening the centre section of the body are large angle section pressings riveted inside the outer panelling, in conjunction with which they form a massive tube on each side of the body at floor height. The front bulkhead is shaped to pass inside this large fabricated tube, but a second bulkhead is located on top of it, slightly behind the main one. The space between the two is closed at the top by the outer panelling, and a plate is riveted to their lower flanges to form a deep box section scuttle across the structure. The outer panelling is 18 S.W.G.

Two box section stiffeners are riveted on the rear face of the rear bulkhead to form attachment points for the rear suspension assemblies, which are bolted to channel sections running vertically down the rear face of the bulkhead. Between the bulkheads, the body forms a rigid tube, with a large aperture cut in the upper panelling to allow the driver to reach his seat. The passenger's seat is normally enclosed by a small plate which fits on flanges in a second, much smaller aperture alongside the driver's opening. From the front bulkhead forward, the front of the body is a sheet metal assembly that hinges forward to provide access to the engine and front suspension. Its pivots are in extensions of the main framing ahead of the front cross member. Behind the rear bulkhead, the body is also unstressed, and is bolted to the rear bulkhead; it contains the spare wheel and fuel tanks, and can be removed for access to the rear suspension assemblies.

An interesting application of similar ideas in a saloon model is seen in the Bristol 405 four-door saloon. This has a straightforward chassis frame, with 6½ in deep, 14 S.W.G., box section side members fabricated from flanged channel sections with a 14 S.W.G. closing plate. The front and rear 12 S.W.G. cross members are similar in section, but a 3½ in diameter tubular cross member is employed in the centre.

At the rear of the body, a semi-stressed skin structure forms an extension of the frame to carry the fuel tank and luggage locker. The main side members end in short cranked extensions. Across both is a steel angle-section framing to which is riveted a light alloy diaphragm. The inside walls of the luggage locker are riveted at right angles to this and extend to the rear. The fuel tank is attached to the diaphragm, and a second diaphragm, of similar construction to the first, is riveted between the locker side walls. This seals off the tank from the locker, and forms a deep box section between the two diaphragms. The locker floor is riveted to the flanges at the bottom of the side panelling, and additional rigidity and locker space is provided by deep sheet metal boxes inset in the locker side walls.

The Morris Oxford and Cowley, Austin A40, A50 and A90 models, Lanchester Sprite and the Hillman Husky are of chassisless construction. In the Husky, frame members of box section form part of its integral, body-frame structure. The main strength of the structure is in the massive scuttle assembly, to which the box-section dash contributes some strength. The floor pressing, with the toe ramps, rear seat pan and rear floor, adds lateral stiffness. The rear suspension units are attached to box section frame members welded under the floor. These frame members extend the full length of the body, and are cranked inwards at the front to support the front cross member and suspension components. In the Austin Cambridge models, the main structural members are the scuttle, wing valances, floor, seat ramps, rear wheel-arches, and locker floor.

Top hat section members are spot welded to the main pressings at points of stress concentration, to form box section longitudinals. They extend the whole length of the body and are swept inwards at the front to provide wheel clearance and are attached to the front cross member. This member in the Cambridge, as in the larger A90 Westminster, is a deep cranked pressing. At its extremities are both the upper pans

for the coil springs and the mounting brackets for the shock absorber-wishbone assemblies. The front and second cross member supporting the rear of the gearbox are bolted to the structure to facilitate repair. Two inverted top hat sections, identical to the main longitudinal stiffeners, are welded across the body to form outriggers supporting the box section sills. In the A90, pressings at the base of the scuttle provide the additional stiffness required to accommodate the extra bending loads. Spot welding is employed in the assembly of the body pressings, and weight and cost have been saved by eliminating soldered joints. This is seen particularly in the shape of the roof pressing. On each side is the conventional J-section drip moulding, to which a top hat section with an additional flange on the inner edge is spot welded. This constitutes a box section cant rail, although a simpler stiffener is used to form the screen rail itself.

The Morris Oxford and Cowley models go a stage further towards monocoque construction, in that although top hat section stiffeners are welded beneath the floor pressing to support the rear suspension, scuttle and front suspension, they are not continuous. At the rear the longitudinals are attached by stout brackets to the base of the heel board, while the front ones are welded to a cross member that carries the front torsion bars. This cross member is formed of two channel section pressings, enlarged in the centre to accommodate the propeller shaft, and welded back to back to support the tunnel. The main floor pressings are deeply embossed to increase their rigidity and to eliminate drumming. At the front, the wheel valances and the scuttle form a welded unit, with the wing panels bolted on; at the rear the wheel arches and wings are part of the structure.

In the Lanchester Sprite, exceptionally deep, box section sills, and a simple flat floor pressing, incorporating the propeller shaft tunnel and the rear seat ramp, form the basis of the structure. A transverse, top hat section pressing supports the rear engine mounting; but the front suspension and engine are cradled in a pair of box section, forked members extending downwards from the scuttle and triangulated with another pair of box section members parallel to each other and extending from the front cross member to the rear engine mounting cross member.

At the rear of the body, the springs are mounted on box section brackets, while lateral stiffness is ensured by the floor of the luggage locker, and by the rear bulkhead to which the wheel-arches are spot welded. Although the body shell is of steel, light alloy doors and bonnet and boot lids are used to keep weight to a minimum.

The M.G. Magnette is another light weight chassisless model in which the main body pressings provide rigidity with a minimum of local stiffeners. Much of the stiffness in the floor is provided by the propeller shaft tunnel and rear seat ramp, and additional support is given by a central cross member and the deep, box section sills. The rear springs are mounted on box section brackets. Cross members, supporting the front engine mountings and front suspension, and the rear engine mounting, are tied to longitudinal box sections welded to the floor at the front.

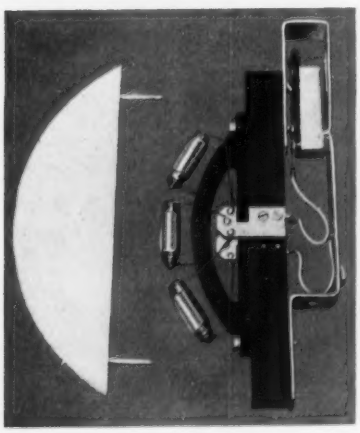
In the new French Ford Vedette models, box sections of exceptional depth are used to support the body pressings. At each side of the main floor pressing, box sections are formed. They extend from ahead of the rear wheel-arch to a point in front of the scuttle. A box section cross member is welded between these side members at the base of the scuttle. From it, two cranked longitudinals extend forward. They carry the wheel valances, which are welded and stiffened at their upper edge by a deep flange. Above the front springs, these flanges are enlarged to form their upper pans. Diagonal bracing members extend from the spring pans to the scuttle. The semi-elliptic rear spring supports are cranked channel sections welded underneath the floor. The body itself is framed in square section tubular pressings. Further reinforcement of the sills is provided by box section cappings, which are welded on to them.

ELECTRICAL EQUIPMENT

Further Development of Flashing Indicator Installations

IN the electrical field, the Motor Show has not brought to light many new developments. This is to be expected; for as a result of intensive development in past years, present-day products have reached a very high standard. Development still proceeds, but the results cannot be so spectacular.

A policy of rationalization has been undertaken in recent years by the car manufacturers and the electrical equipment firms with the object of reducing first costs and also the variety of spare parts that have to be held. The fact that, in the main, the electrical components continue as before can be taken as adequate indication that reliability and performance are good and that initial costs are as low as economically possible. This Show has, of course, reflected the recent changes introduced by the Ministry of Transport in regard to the legalizing of the flashing light type of direction indicator.



Belling and Lee flashing direction indicator with amber cover removed and placed alongside

Flashing indicators

Many of the car manufacturers have been quick to change to this form of direction indication, although it is by no means universal. From an installational aspect, the system is attractive in a number of ways. The indicator lamps are simple to mount and can easily be blended into the styling—in the majority of cases the rear stop lamps are used as the indicators. Apart from possible bulb failures, the equipment could be more reliable over a period of time than the semaphore type, which is always open to the climate and to dust.

Joseph Lucas Ltd. were showing their flasher system, in which a hot wire is employed; an extension of the

The Lucas windscreen wiper motor type DR2 has a high torque output and is suitable for windscreens of double curvature

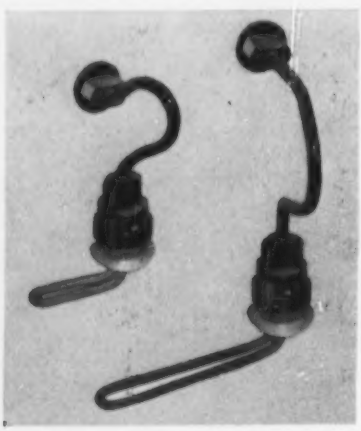
This flush top Exide battery is easy to clean and occupies a minimum of space

wire operates a switch. This is their standard unit and works with a variety of indicator lamps. New this year was an amber lamp, type 559, of suitable shape for mounting in door pillars.

Trico-Folberth Ltd. use a similar hot wire system. A new control switch was shown for steering column mounting, incorporating a warning light which flashes in anti-phase with the indicator lights. Should these lights fail, so does the indicator.

A novel unit was shown by Belling and Lee Ltd. for fitment in place of the semaphore type of direction indicator either when that unit requires replacement or should an owner wish to equip his car in line with the latest developments. The ingenuity of the design is such that the whole unit, incorporating flashing mechanism, bulbs and amber cover, is no wider than the existing semaphore arm equipment.

The framework of the unit has identical fixing arrangements to that used for the existing design. In addition, the same wiring termination is used. A bi-metal cut-out type of flashing control and three 6 W festoon type bulbs mounted in tandem and wired in parallel, are mounted on the framework. The regulation minimum of 15 W is well exceeded. The bulbs are covered by a removable amber coloured plastics moulding. Because of the simplicity of the system, no changes are necessary to vehicle wiring or switching. A failure of a bulb merely reduces the light intensity.



The Key-Leather, Gulf Stream immersion heaters are for maintaining the engine as a reasonable temperature when stationary in cold weather

Lamps

A new long-distance driving lamp was shown by Ceag Ltd. It was a 7 in unit of the modern shallow design carrying a clear curved front glass in the centre of which is mounted a bulb shield. The glass is held to the lamp body by means of a clamp ring and a safety clip is incorporated to hold the lens and reflector in position when the clamping is removed.

Joseph Lucas Ltd. showed two lamps: the SLR 576 and the SFT 576. Both are in a large degree smaller versions of the 7 in diameter 700 Series, and are 5·75 in diameter. The light output is about 80 per cent of the 100,000 candle power of the 7 in unit. The SLR unit is of the pencil beam type, having a clear front glass, while the SFT lamp provides a flood illumination with a flat top cut off. Both are fitted with bulb shields carried in the front glass.

Another auxiliary lamp is the Saucer lamp Mark II, which was shown by Butlers Ltd. As the name implies, this again is a shallow design, but in this lamp the pre-focus bulb is inserted from the front through the glass. A spider inside the glass brings the electrical connections to the centre and a small diameter screw-on cap holds the bulb in position and makes the lamp waterproof. The complete lamp is just over 6 in diameter.

Needless to say, many makes of red reflex reflectors were shown. Joseph Lucas Ltd. had on view several rear lamps in which the reflector forms an integral part, the lamp cover and reflector being a moulding in Diakon, a clear thermo-setting plastics.

Belling and Lee Ltd. have made improvements to their Save-A-Life device. This is a portable lamp unit designed so that when connected to the car electrical supply, illumination is available for emergency roadside repairs at night, and at the same time a flashing red light warns other road users. A single, double-filament bulb is used, one filament being flashed by means of a bi-metal cut-out. The construction is such that the hinged red Diakon cover has to be brought up to the vertical position to make it ready for operation. In this position, the bulb is open to the atmosphere and is well ventilated. To prevent operation with the cover closed, which would cause damage to the moulding through overheating, a mercury switch is included in the circuit.

Windscreen wipers

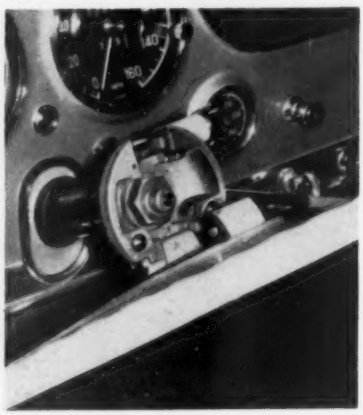
Joseph Lucas Ltd. showed an improved electric windscreen wiper, type DR2, giving increased torque for use under arduous conditions on double curvature windscreens. The unit is operated by a rack, which moves in solid brass tubing. With the advent of higher operating loads, the use of flexible tubing for this purpose is no longer possible. As shown, the motor was of the single speed type but a two speed version (with an extra winding in the field) is to be introduced. Mechanical connection between the motor and rack is by means of a crank, worm driven by the armature shaft and driving a connecting rod with the small end moving in a cross head, to which the rack is attached.

The unit is self-parking, a contact in the cover over the crank and operated by the crank pin ensures that the rack, and consequently the wiper blades, is at the end of its stroke before the motor is switched off. This wiper now gives a stalled torque of 900 lb-in against the figure of 600 lb-in for its predecessor. It is available for 6, 12 or 24 volts.

The Ceag long distance beam lamp

Batteries

Micro-porous separators, either rubber or polyvinyl chloride, are now used by the majority of battery manu-



In the Mercedes Benz 300SL, access to the horn button is gained by pivoting the steering wheel down

facturers. These separators give greatly increased shelf life and improved general operating reliability.

Chloride Batteries Ltd. showed a range of Exide batteries in which the top has been redesigned to give a flush appearance. This has been done by reducing the size of the inter-cell connectors and recessing them into the top moulding. The result is a much cleaner appearance, a significant saving in lead and therefore weight, as well as a reduction in battery height. The new design will be much easier to clean. Provision for checking the voltage of each cell is retained, since a portion of each connector, about $\frac{1}{4}$ in square, projects slightly above the filling compound.

Miscellaneous

A novel radio aerial was seen on the stand of World Radio Ltd. This is of the telescopic type in three sections and extends to 50 in. It is intended for mounting in the front wing of the car. Elevation of the aerial is effected electrically and does not take place until the radio set is switched on. A small 12 volt motor provides the motive power. It is mounted remote from the aerial, but is connected to it by a flexible tube. The actual drive is by means of a nylon tube which is moved axially by the motor and pushes the sections of the aerial up vertically. Similarly, when the set is switched off, the motor is energized and the aerial is retracted. Limit switches are provided in both the up and down positions to cut out the motor. In the down position the sections are locked and cannot be extended by hand. The excess length of the operating nylon tube in this position is accommodated within another tube which is cleated in any out of the way space within the car.

Unorthodox doors are used by Mercedes Benz on the type 300 SL sports coupé. These form not only part of the vehicle sides but also part of the roof and are hinged at the top and open by swinging outwards and upwards. In order to facilitate entry to the driver's seat the steering wheel is hinged at its hub and can be swung downwards and under the steering column. This arrangement has a secondary advantage in that access is readily given to the horn button switch, which is normally operated by a loose, horn push disc at the centre of the steering wheel.

By moving a lever to rotate a cam mounted on a small shaft carried between lugs on a flange at the top of the steering column, the steering wheel is freed on that side and can hinge about a pin in similar lugs diametrically opposite on the flange. When in this position, the horn push proper is exposed to view and is readily accessible for maintenance.

There is nothing new in immersion heaters for car engines, but the unit known as the Gulf Stream, shown by Key-Leather Co. Ltd., is particularly simple. This unit is mains operated and is for maintaining engine coolant at a reasonable temperature when the vehicle is stationary in cold weather. Alternatively, it can be employed for pre-heating prior to starting from cold.

BODYWORK

A Wider Range of Styles, But Few Major Developments

EACH Motor Show in the period 1948-53 included certain models which were outstanding on account of their styling and the method of construction employed. Of the 1954 exhibition, it is fairly safe to say that there was nothing outstandingly new in either of these respects. Evidently in the immediate post-war years both car manufacturers and coachbuilders were seeking to establish a reasonable line of development that would be acceptable to the motoring public. Now, the manufacturers are consolidating their ideas and it is probably for this reason that the cars displayed did not indicate any major development in either line or construction. In general, there were only slight modifications, and invariably they have been introduced to simplify production procedure or to meet customer requests. One thing did predominate; it was the increased employment of the integral method of construction.

The range of body styles is perhaps wider than it has ever been. In particular, reference must be made to the several dual purpose bodies now being produced on small chassis. Each of the big car manufacturers marketing a medium price model now includes in his range a vehicle that gives most of the comfort of a four or five passenger saloon while yet allowing a good quantity of luggage to be loaded behind the rear seat. In addition, the rear seat is invariably made to fold forward, thus increasing the space available for luggage disposal when only two or three passengers are carried.

Reference to these dual purpose vehicles would not be complete without some comment on the external appearance that results from the more angular rearward portion that the provision of increased luggage capacity renders necessary. One manufacturer, however, does provide all the essential features of the dual purpose vehicle without departing to any marked extent from the conventional lines of the normal private car. Other manufacturers, whilst retaining the front and possibly the rear doors of the standard saloon body, so style the rearward portion that it is quite obviously a goods carrying vehicle. It is to be hoped that future additions to this range of useful bodies will retain as far as possible the private car external appearance.

Amongst the several new cars listed by chassis manufacturers there are some interesting models. Naturally the introduction of new cars by such well-known concerns as Austin, Morris and Hillman enables a fairly accurate forecast to be made of the design trends in medium priced vehicles, and it is obvious that, as one would naturally expect, a very careful study of the demands of potential users has been made.

On the new Austin Cambridge, a four-door, four-light saloon, there is no attempt to define the front and rear wings. The front wing, which is closely identified with the bonnet formation and headlamp mounting, is carried through at waist height and ultimately forms the side panels of the boot. Thus the extension of the front wing provides the body side panel, or in actual fact the lower door panels, and the body above the waist is inset to give a very stable and compact appearance. In conformity with modern practice, particularly as exercised in America, the rearward ends of what would normally be the rear wings are of high blunt form to harmonize with the contour of the roomy boot. This effect is in some degree reproduced at the front end, where the headlamp housing necessitates a vertical face for the forward edge of the front wing.

The front wing and door panels are relieved by a swaged line commencing at the headlamp and passing on to the door panels in a gradual downswept curve. Another outstanding feature of this design is the deep moulding effect that is introduced along the bottom of the body and also on the lower edges of the outer wing valances. This gives some protection to the side panels, since it forms a substantial rubbing strip, and also provides reinforcement at points where most needed. Without this lower panel edging and the swaged line on the body side, the appearance would be plain, but this minimum of relief suffices to produce a most attractive looking body.

Integral construction has been adopted for this new Austin Cambridge saloon, and the body contains a number of interesting features that repay careful study. For example, the bonnet, which is hinged on its rearward edge and extends in one piece from the base of the windscreen to the top of the low and unobtrusive radiator grille, contains under its upper panel a substantial air duct into which air enters through a raised frontal inlet to pass to a heater unit against which a rear orifice in the duct abuts when the bonnet is shut. Air loss is prevented by rubber seals. By this arrangement fresh air is also passed to the interior and there would seem to be much to commend this arrange-

ment in preference to the costly system of ducting that has been used in the past. Furthermore, the Austin system is noteworthy for the fact that it in no way interferes with servicing work on the power unit.

Another noteworthy point concerns the mounting of the front wing units, for in the interests of easy replacement in the event of damage, these wing pressings are bolted to the valance plate assembly. The bonnet panel, apart from the raised central portion that assists in providing the air duct and thereby gives relief to what would otherwise be a broad expanse of plain panel, has substantial box sections at the edges which add much to its stiffness. The body shell itself is entirely composed of steel pressings, and since there is no separate chassis frame, much attention has been paid to the formation of the floor which embodies longitudinal box sections, with auxiliary box sections to give an extremely stiff base structure. For the mounting of the major units such as front suspension, engine and gearbox, box section cross members are introduced. It is also evident that the problems of flow production have received very close attention.

For example, all lead loading is eliminated and panel joints are effected by turning flanges at right angles and spot welding. Thus, pre-finishing treatment is not necessary and the clean gap between the panel joints is unobtrusive.

One criticism that can perhaps be made in connection with this new Austin saloon, concerns the luggage boot which although of ample dimensions (it will house 14 ft³ of luggage) has a panel extending for some height above the floor to accommodate the rear number plate and other necessary lamps. Thus to load luggage, it is necessary to lift each piece over this panel. In carrying this out, it is conceivable that the paintwork may easily become damaged.

The luggage locker itself is well arranged and is provided with a lid of large dimensions hinged on its forward edge and having substantial box sectioned edges. As is becoming common practice, the petrol tank is arranged immediately behind the rear seat squab board; its filler is on the near side and may only be reached when the lid is open. Similarly, it is only possible to remove the spare wheel when the locker lid is raised, for the wheel itself is carried beneath the boot floor in a hinged cradle that is lowered by engaging the starting handle with a suitable screw on the boot floor itself. When fully lowered, the spare wheel can be withdrawn from beneath the bumper.

A slender centre pillar has been obtained on the B.M.W. 502 by hinging the doors on the front and rear pillars

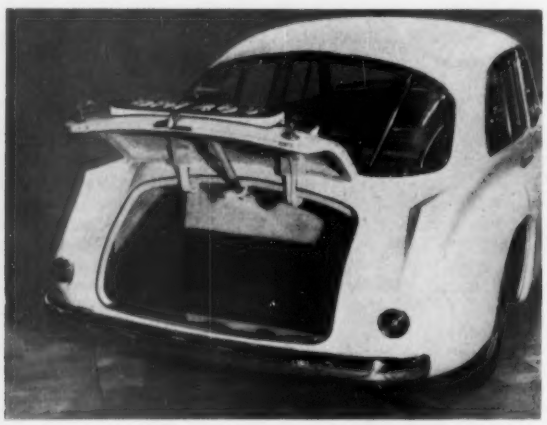
There is a curved windscreen and all door windows are arranged to drop, a counterbalanced mechanism being used, thus avoiding internal winding handles. To prevent the windows from being forced when the car is unattended, they can be locked in their closed position by the operation of a small finger lever which, if required, may also be made to secure the window in a position that leaves an opening of ½ in. All doors are hung on their forward pillars and press button locks are used.

Another new model introduced by the Austin Motor Co. is the A90 Westminster, which in general utilizes the panels of the Cambridge saloon, but additional width has been obtained by adopting a wider centre section, and the moulding treatment used on the side panels is most distinctively arranged and favours alternative colour schemes. This model also has the air inlet duct running beneath the bonnet panel.

In the new Hillman Husky, the manufacturers have developed an extremely versatile vehicle which can be made to provide most of the comfort of a normal touring saloon while yet accommodating a considerable amount of luggage. A further advantage is that the rear seat is so arranged that it can be folded forward to rest against the backs of the front seats; thus when only two passengers are travelling there is considerable floor space at the rear for luggage. Access to this luggage area is through a large door hinged on the off-side of the rear panel. This dual purpose function has been achieved without materially departing from the conventional lines of a private car.

As is the case with the Hillman Minx range, this new model employs integral construction. Wherever possible existing Minx pressings have been employed; they are used for the complete front end, including the front doors. There is only one door on each side, since the wheelbase is 9 in shorter than the current Hillman Minx and a second door would not be possible. The side doors are fitted with drop windows and have the usual ventilation panels, but all the windows at the rear of the car are fixed. Naturally, the interior trimming is not of the same order as that of a normal saloon, but it is nevertheless a pleasing style and should give satisfactory service in this interesting dual purpose vehicle.

On the Austin A50, an air duct is incorporated on the bonnet lid



No space is wasted in the luggage boot on the Bristol 405 Saloon

A study of this plastics body on the Jensen 541 chassis shows that original thought has gone into the design, which is specifically suited to this material

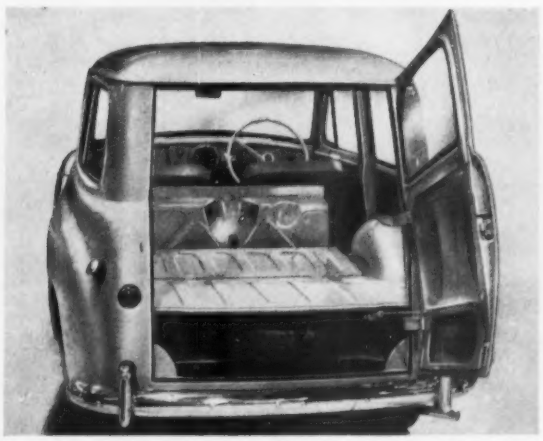
In the new Morris Cowley, every endeavour has been made to provide ample seating space within the wheel base, and for this reason the engine is located well forward of the front wheel centres. In regard to external appearance, the front wings are carried rearwards over the door panels at waist height, and the width over the wings reduces gradually as they pass to the rear; thus it is necessary to employ obvious rear wings. At the front end, the wings are very much a part of the bonnet formation; the bonnet top panel, which is hinged on its rearward edge, maintains its width towards the front and gives excellent access to the engine. Care has been taken to preserve body silence and particular attention has been given to the incorporation of anti-rattle devices in moving parts such as the bonnet top panel. This panel, as every service department knows, is a frequent source of annoyance. On the Morris Cowley the bonnet panel, the lock of which is controlled from the front seat, has a coil spring at each front corner exerting an upward pressure. There are also rubber buffers on the front wing inner valances.

On this car the fuel tank is again located behind the rear seat squab with its filler protruding on the right hand side and having a neat external cap. The spare wheel is carried on the right-hand side in a vertical position within the luggage locker. A low locker floor has therefore been made possible, and to accommodate the spare wheel it has been necessary to provide a well which has a drain hole. The locker lid is hinged on its forward edge and when raised is supported by a stay. As the number plate and its light are mounted on the lid itself, it has been possible to extend this hinged panel to a point just above the bumper, to make luggage loading a relatively simple matter. As small tools are not provided, no special provision is made for housing them. However, since few motorists will care to undertake any journey without a reasonable assortment of tools, it is felt that some provision for their accommodation should have been made. Similarly, no special attachments are fitted for the accommodation of the jack and starting handle.

In general form, the new Morris Oxford is similar to the smaller model in having high wing treatment, a curved windscreen and a similar luggage locker arrangement. On both models the rear end of the bonnet contains an air inlet that admits fresh air to a heating and demisting unit. These new Morris models resemble the new Austin Cambridge in having the prominent wing valance and lower body panel moulding which is part of a box section that provides rigidity. In the arrangement of the seating, the rear seat squab is curved forward at each end to prevent the wheel arches from causing inconvenience. A further point concerning the interior trimming is that the arm rests on the rear doors are comfortably padded and also act as convenient door pulls. This Morris Oxford saloon also is constructed on the integral system.

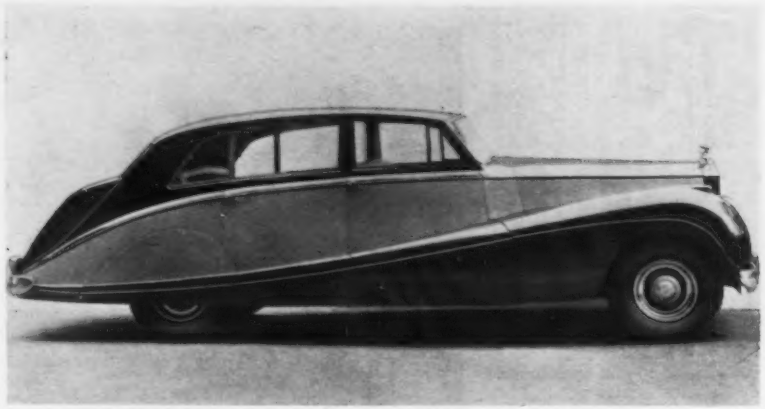
It is interesting to note that for the new Lanchester Sprite, integral construction has been adopted. This is the first time that this particular concern has produced a vehicle without a conventional chassis frame. Another point of interest in this new Lanchester model is that light alloy material is employed for the bonnet, doors and locker lid, the object, of course, being to save weight. In this connection, it should be mentioned that the weight of this 1,622 cm³ saloon with 10 gallons of fuel is 2,352 lb.

While the integral method of construction is practically universal where at least a fairly large output is intended, for lower outputs constructional methods are still closely identified with the traditional composite method. Exactly how far this time-honoured method is used seems to depend very largely upon other activities in which the manufacturing company may be engaged. For example, the Bristol models give some indication of the effect on body construction of the close relationship between aircraft and motor manufacturing divisions of the same company. The new Bristol 405 has a body shell that in its main construction is a combination of ash, ash laminations, light alloy and steel, with an 18-gauge aluminium alloy panelling which also plays its part in stiffening the body structure. From a design viewpoint this new Bristol, a four-door, four-light streamlined saloon, has a number of interesting features, not the least of which is the mounting of the spare wheel on the left-hand side between the front wheel and the screen pillar. Access to this spare wheel is had through a hinged flap which lifts up upon release to enable the spare wheel to be withdrawn with little effort. In fact this hinged flap represents the entire panel



There is ample luggage space in the Hillman Husky dual purpose car

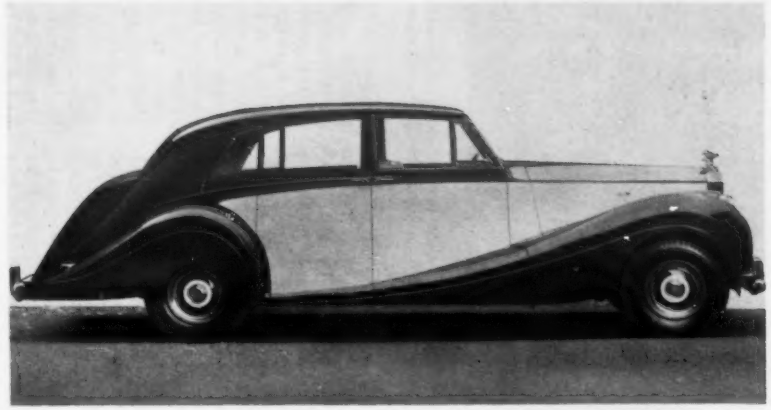
On the latest version of the Rover 90 saloon, the rear window and boot have been modified



Freestone and Webb four-door, six-light, touring limousine on the Rolls-Royce Silver Wraith long wheelbase chassis. This exhibit was awarded the Gold Medal in respect of Section I, by the Institute of British Carriage and Automobile Manufacturers

Hooper touring limousine on a Rolls-Royce Silver Wraith chassis. An interesting feature of the Hooper exhibits is the use of insulating material under their roof panels to minimize heat transfer into or out of the saloon

The Empress saloon, by Hooper and Co. (Coachbuilders) Ltd., on a Daimler special series, 3½ litre chassis



Rolls-Royce Silver Wraith, four-door, six-light, saloon limousine with division, by Freestone and Webb Ltd.

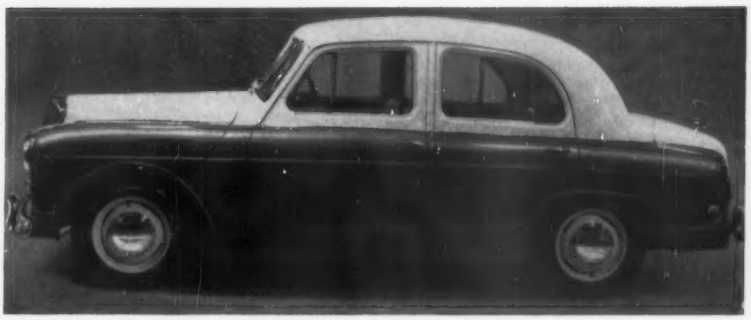
surface below the waist moulding between the front wheel and the door hinge line. A similar flap on the right-hand side of the car covers a compartment in which the battery and other auxiliary details are situated.

This spare wheel arrangement has been used before. It does allow a satisfactory increase in luggage locker accommodation, but it can only be used on a chassis of good length where the engine is located behind the front wheel centres, and there are to-day increasingly fewer cars with this characteristic. In the roomy boot of the Bristol 405 a 16-gallon fuel tank is mounted high against the back of the rear seat squab board to give additional luggage space between the bottom of the tank and the low boot floor. The luggage capacity is still further increased by the introduction of recesses at each side extending into the rearward sections of the well swept wings. It is felt that this arrangement could serve as a model for those designers who desire to feature the luggage carrying capacity of their creations.

In the Daimler Regency sports saloon which has been modified to accommodate two different engine sizes, and the bonnet is therefore longer, it is noted that the spare wheel arrangement which was included in this model when it was introduced two years ago is retained. The spare wheel is carried in a cradle beneath the boot floor and is lowered to allow the wheel to pass beneath the bumper by the rotation of a nut projecting through the luggage locker floor.

In general, the Rover saloon has been little changed but some modification has been made to the styling of the rear end. In particular the rear light is now carried around the rear corner panels to embrace a portion of the roof quarters.

An excellent example of the use of resin glass fibre material as a panelling medium, reinforced where necessary with tubular members, was to be seen in a most attractive two-door body shown by Jensen. Apart from its technical interest, the styling of this saloon design is extremely good, the wing structure being combined very closely with the lower panel contours. The body is of aerodynamic form and its low well-curved bonnet is followed by an inclined curved screen, while the roof panels merge into the locker panels with no break. There is the usual large rear light which leaves practically no blind quarter panel.



The Lanchester Sprite is of integral construction and some of the panels, for example the doors, and bonnet and boot lids, are of aluminium to reduce weight

The moulding treatment on the Austin A90 saloon favours a dual colour scheme

This chassis manufacturer also accommodates the spare wheel beneath the boot floor, a projecting nut being rotated by the wheel brace when the wheel is required for use. Another interesting point in connection with this car is the pivoted panel used to seal the grille orifice at the front of the bonnet panel; this pivoting flap is controlled from within the car.

Plastic materials are also used for the production of a detachable coupé roof that is now available for the Triumph TR2 sports two-seater, which hitherto has been supplied with the normal folding hood. The new reinforced glass-fibre top is intended to be adopted at the beginning of the winter season and left in position until good weather can again be expected. It is secured by a spigot at the top of each screen pillar and one in the centre of the screen. The rearward portion of the detachable top is secured to the rail behind the seats by four fastenings which involve the use of a nut, a threaded spigot being passed through drilled plates screwed to the inner face of the rail.

In the section devoted to special coachwork, the bodies in general were similar to those that have appeared before. One outstanding example was the striking drop-head coupé exhibited by Park, Ward & Co. Ltd. on a Bentley Continental chassis. Previously this chassis has carried saloon coachwork of aerodynamic form but Park Ward are now producing both fixed head and

A detachable plastics roof has been made available for the Triumph sports two-seater

On the Bristol 405 saloon, the spare wheel is housed forward of the near side door

The Bentley Continental saloon by Park, Ward and Co. Ltd.

drop-head coachwork on this high class sports chassis. Naturally the opportunity has been taken in designing these two bodies to use common lower panels and since both are of coupé form, this has had no detrimental effect on the appearance of the two cars. The essential feature of the design is the blunt formation that characterizes the forward portion of the front wing, which after reaching its maximum height above the front wheel centre, falls very slightly as it passes on to the body side panels until it ultimately merges into the rear wing; however, since the front wing extension, as it passes across the door panels of which it forms a part, gradually reduces in width, the rear wing is prominently outlined. The forward portion of the rear wing follows normal shape, but behind the wheel centre the wing retains its height, falling only slightly towards the rear; this line is also common to the luggage locker.

In the construction of these bodies, Park Ward have used their patent method of metal construction. Light alloy materials are used in each case, the bodies being panelled in aluminium. There is a large luggage locker which has the spare wheel in the centre of the floor, the remaining space being occupied by six fitted suit cases. The luggage locker lid is hinged on its forward edge and is balanced. Seating is provided for four passengers and to facilitate entry to the rear seats, the backs of the separate bucket type front seats fold forward. This is necessary because these are two-door bodies. In its operation the folding head is extremely light and is readily manipulated by one hand. A recess behind the rear seat is so devised that when the hood is folded it lies with little projection above the surrounding panel area, and a cover is provided to retain the clean appearance that distinguishes this attractive car.

As already mentioned, the fixed head saloon shown on a Bentley chassis follows similar lines and this also has a light alloy body framework. In this two-door, four-light body, the quarter window is of large dimensions and there is also a very large back light which is provided with demisting equipment; these windows, together with the curved screen, provide excellent visibility, both to the front and to the rear. A shallow metal channel divides the door and quarter glasses, and the framed door glass includes a pivoting ventilation panel at its forward end.

The Silver Wraith touring limousine displayed by Park Ward is once again an excellent example of the dignity and style which a reputable British coachbuilder can achieve on this high class chassis. Perhaps the outstanding feature of this particular body is the striking front wing design that is carried out with a falling line across both doors to meet the rear wing near its base. The large boot is well equipped and has a lifting lid, whilst the interior of the body provides seating accommodation for five or six passengers; a full division is fitted.

One of the interesting features of the special coachwork section was to be found on the stand occupied by H. J. Mulliner and Co. Ltd., who in the past have usually produced a body of outstanding novelty in both construction and styling. On this occasion neither of these points was much in evidence, for the bodies on display were all of a type that have been seen before. The Bentley Continental saloon, for example, is retained in its original form. A point of particular interest is the installation in a four-door light weight Bentley saloon of air conditioning equipment in which the air is taken in and put through a small conditioning unit before being passed to the interior of the car. This air conditioning unit, made by the Longford Engineering Co., is installed behind the rear seat squab board where it occupies some of the valuable luggage space in the luggage boot. However, for those using this car in a country where high temperatures are experienced, the loss of luggage space will not be regretted when the interior of the car can be maintained at a reasonable temperature. Although it is not yet possible to say just how much temperature drop is possible, it is expected that it may be in the region of 30 or 40 deg F.

The air conditioning unit is fed by ducts arranged under each sill, with inlets at each side of the front apron, and the conditioned air is taken up the quarter panels and ducted along the cant-rails, whence its release to the interior is under the control of the passengers. This application of an air conditioning unit makes an interesting

Convertible coachwork on a Bentley Continental chassis, by Park, Ward and Co. Ltd.

The rear end styling of the Park Ward convertible model of the Bentley Continental conforms with modern trends

study and its future development will be watched with interest, for undoubtedly now that it has been proved possible in a private car, others who travel in warm countries will favour its inclusion in their vehicles.

As in the past, H. J. Mulliner continue to pay special attention to the problem of weight reduction and their experience in the use of light alloy materials has proved that durable coachwork is possible, whilst the saving in weight has been of benefit in enhancing chassis performance and the many other problems affected by the right construction.

A Daimler touring limousine shown by Hooper and Co. (Coachbuilders) Ltd. clearly showed the versatility of this Company's craftsmen. The trimming is most unusual, the rear seat being trimmed in silver-grey brocade. As is usual with Hooper coachwork the body is wide and its width in the region of the rear wheels is such that the wing does not extend beyond the outer panels. The rear wheels are enclosed by hinged wing panels, which extend to the lower line of the body.

Another point of interest in this body is the use of independent heaters for front and rear compartments, which are divided by an electrically operated division. The driver's seat is separately adjustable and, as in the past, the door windows are glazed with double glasses to prevent misting. The fixed roof has a glass panel in the rear portion and can be covered at will by an electrically operated sliding shutter. The same method of operation is adopted for the door windows.

The front wings house the head and pass lamps which are situated behind the perspex panel that retains the line of the wing. Laminated safety glass is used for the curved windscreen. In the fitting of the interior, the radio set and its controls are concealed in the rear seat centre arm rest. The whole of the interior cabinet work, instrument board and finishers are covered with blue crocodile skin, and similar material is also used for covering the four suitcases which, together with the spare wheel, are housed in the luggage locker. Both windscreen and back light are provided with demisting equipment.

Decorative paintwork is used on this Daimler touring limousine by Hooper and Co. (Coachbuilders) Ltd.

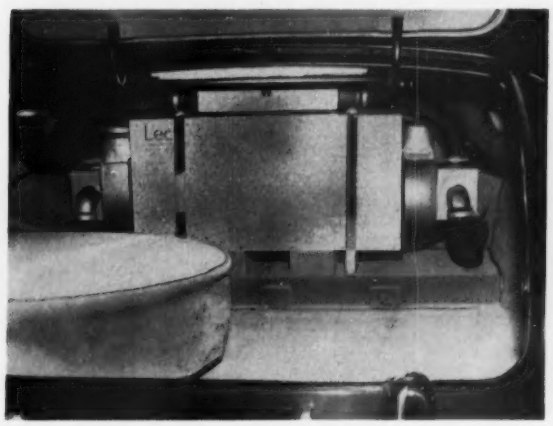
Freestone and Webb Ltd. can usually be relied upon to produce something very attractive on a high class chassis. This year was no exception, for in the sports saloon, a four-door six-light design on a Bentley chassis, the general form shows definite departure from the pleasing but somewhat angular styles that have in the past been associated with this coachbuilder.

The Bentley chassis that carries this coachwork is basically a standard model but to conform to the lines of this design, it has been provided with a Continental radiator cowl and special steering. Thus, the bonnet is low and the general effect is most attractive. The front wings, which have a prominent nose accommodating the headlamps, maintain their height as they pass between the scuttle and fall slightly as they pass over the two side doors. The rear wings have the appearance of separate components, although they are, of course, essentially part of the body panel; in fact the forward portions of these wings are carried on the rear doors and open with them. From a point above the rear wheel centre, the upper line of the rear wing falls in the usual pattern, but at the junction of the body and boot side panels, the wing is upswept to form a peak before falling away again on the line that is in harmony with the luggage locker lid. For a distance of approximately 18 in, this upswept portion of the rear wing crown is provided with a chromium plated motif which adds relief at a point where it is badly needed.

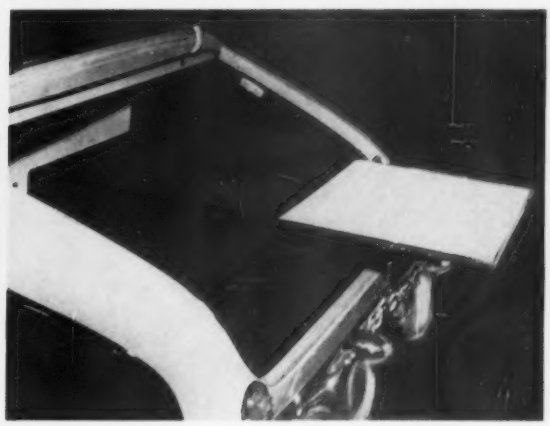
In the construction of this body, although Freestone and Webb have retained the traditional composite method, they have so arranged the timber members—which are of reduced dimensions where possible—that the complete weight of the car compares most favourably with the Bentley all-steel saloon. In addition to lightening the body members, weight has also been saved by paying special attention to the front seat construction, which has been lightened considerably without any detriment to its comfort. Full use has been made of the space within the luggage locker, where the spare wheel is off-set to the right-hand side and is covered by an open-ended structure that can, if desired, be removed entirely by the release of two wing nuts. This spare wheel cover serves a distinctly useful purpose in housing a sliding panel that may be used as a picnic table, and provision is made in the boot for the accommodation of picnic utensils.

As is usual, the luggage locker is provided with a lid that is hinged on its front edge. The doors are hinged on their forward pillars and the front door, in addition to the usual drop glass, contains a pivoting ventilation panel. The corresponding panel behind the rear door glass is fixed.

Of the three cars exhibited by James Young Ltd., the four-door sports saloon



Air conditioning installation in the boot of the Bentley coachbuilt body by H. J. Mulliner and Co. Ltd.



The detachable wheel cover in the boot of this Bentley, by Freestone and Webb Ltd., incorporates a sliding picnic table

Colour treatment emphasizes the striking wing styling on this Bentley coachwork by Freestone and Webb Ltd.

on a Rolls-Royce Silver Dawn is an excellent example of this coachbuilder's appreciation of line construction. The roof line is particularly attractive, and the entire car is one with which little fault could be found. This coachbuilder has also adopted light metal construction and an appreciable saving has been effected, although no indication of this is apparent in the external appearance of the car. In connection with this weight reduction aspect, the Silver Wraith sports saloon which was one of the other two cars, is of special interest, for the complete weight of this capacious car is 43 cwt; a noteworthy achievement.

The Rolls-Royce Silver Dawn and the Bentley, of similar design, compare favourably with the standard saloon and in these bodies a particular feature is the spacious luggage locker which, in addition to the centrally disposed spare wheel, will accommodate 19 ft³ of luggage. In the case of the Bentley saloon, the standard chassis has been modified by fitting a Continental type of radiator which has a more forward mounting than is usual. The headlamp arrangement also is slightly different, the lamps being housed high in the front wing panels.

It is interesting to see how in a conversion of a standard popular saloon, one of the coachbuilders has enlarged his field of activity, particularly so when it has produced a good looking style in a type of body which is becoming extremely popular. The concern referred to is E. D. Abbott Ltd., who have taken the Ford Zephyr saloon and behind the rear door shut pillar have removed the rear roof panel and boot lid, building in its place a well-styled van type of rear end. Perhaps the word van is not truly applicable, for this attractive design for the inclined rear panel with its large window, large side windows and the well rounded roof that maintains the continuity of the forward roof panels, is fully in keeping with the front end styling. In considering the dual purpose models that are now being produced, the Abbott conversion takes a foremost place from the appearance viewpoint. The high forward wings are retained, together with the lower body side panel, and the seating arragements are exactly as used in the standard production model. As is usual with these dual purpose vehicles, the rear seat squab can be removed from its normal position and placed against the backs of the front seats.

With the rear seat so arranged, the luggage loading space is considerable and even with the rear seat in its normal position, there is considerable space behind it for luggage. When the rear seat is folded forward the normal rear doors may be used for luggage loading, but to facilitate the loading of larger articles or for use when the rear seat is normally located, there is a wide door in the rear panel. This door is hinged on the right-hand side and has an efficient check device to maintain the door in its open position. This is necessary since owing to the inclination of the rear panel, there is a tendency for the door to fall shut when it has been fully raised. Concealed hinges are used for the rear panel door and its lock is controlled from within the car.

The added portion of the roof carries a chromium plated rail that increases the luggage carrying capacity. The spare wheel is carried in a vertical position within the luggage storage area and against the right-hand panel. When the rear seat is folded forward a rubber mat may be used to cover the entire luggage loading floor space.

Also shown by E. D. Abbott Ltd. was a Bristol 405 drop-head coupé. This car contains many of the excellent features that are to be found in the saloon version of this model. It has, for example, the spare wheel accommodation on the left-hand side between the front wheel and the screen pillar, with similar accommodation on the offside for the battery and other auxiliary units. In the construction of this drop-head body, the ash frame is panelled in aluminium. In addition to the standard Bristol spare wheel and battery arrangement, the luggage locker layout also follows the lines of the saloon model with its fuel tank mounted high on the squab board, making possible the accommodation of luggage beneath the tank.

The luggage capacity is exceptionally large in this Zephyr conversion by E. D. Abbott Ltd.

The Continental radiator and a modified head lamp mounting are used on this Bentley body by James Young Ltd.

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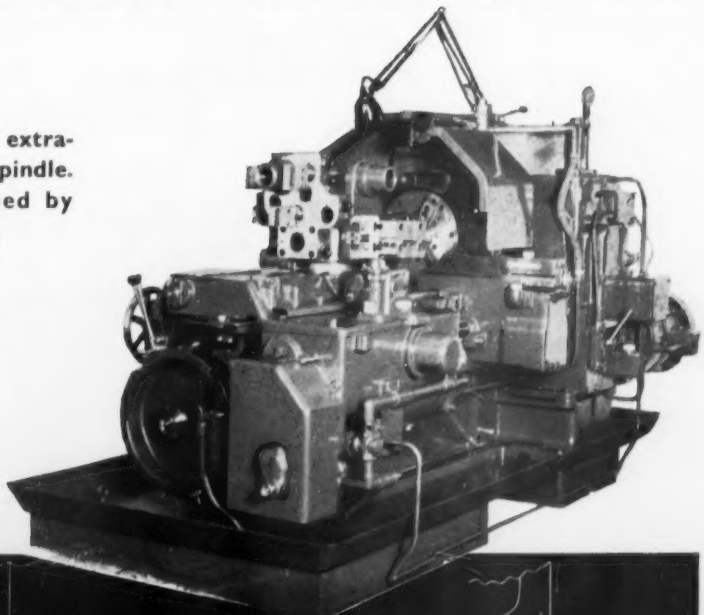

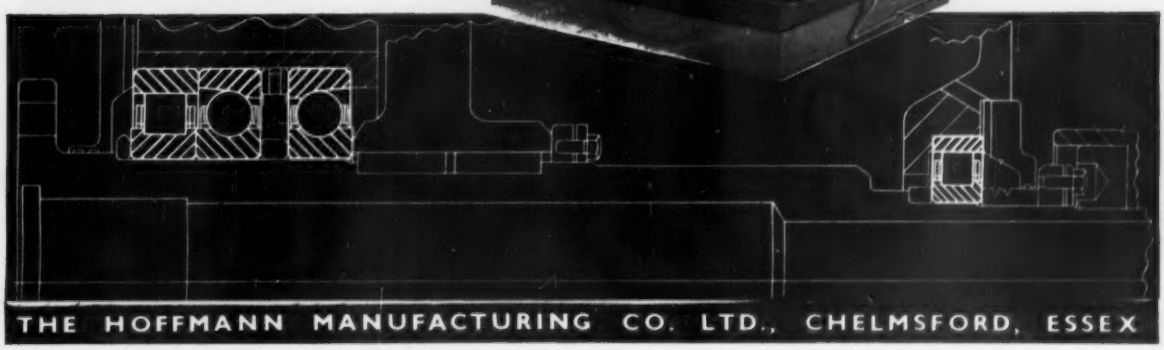

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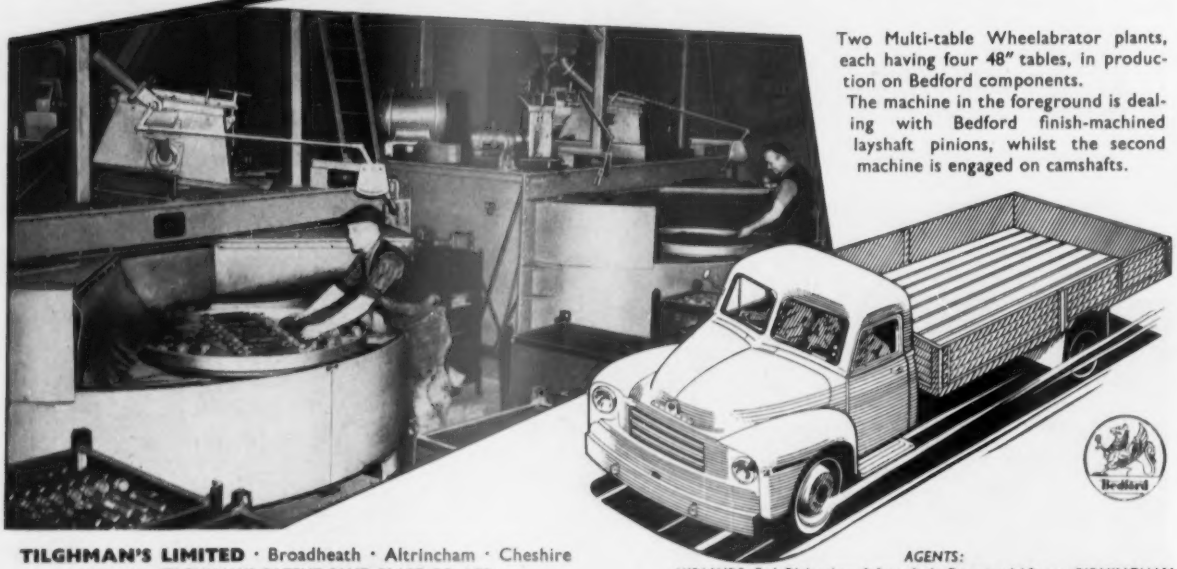

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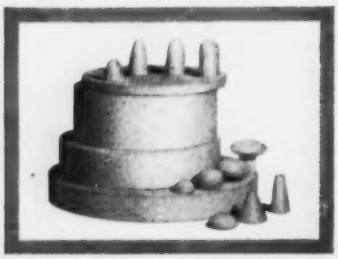

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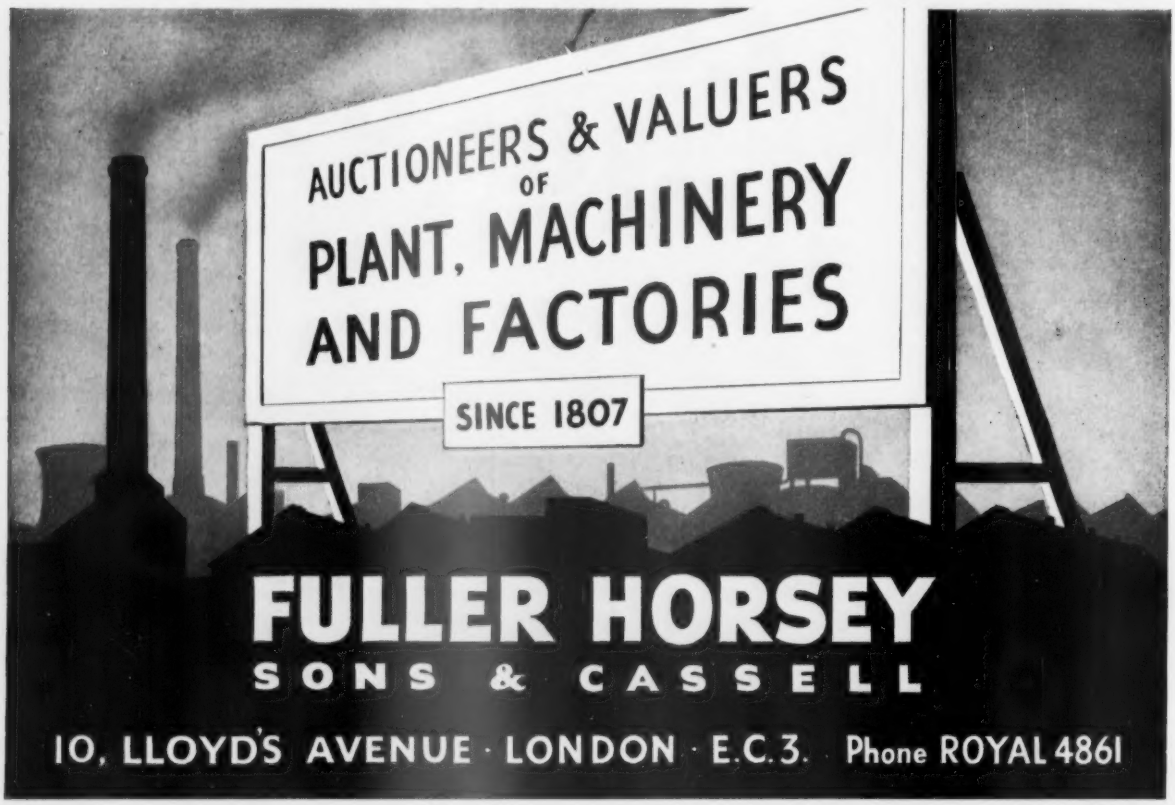

Rathbone

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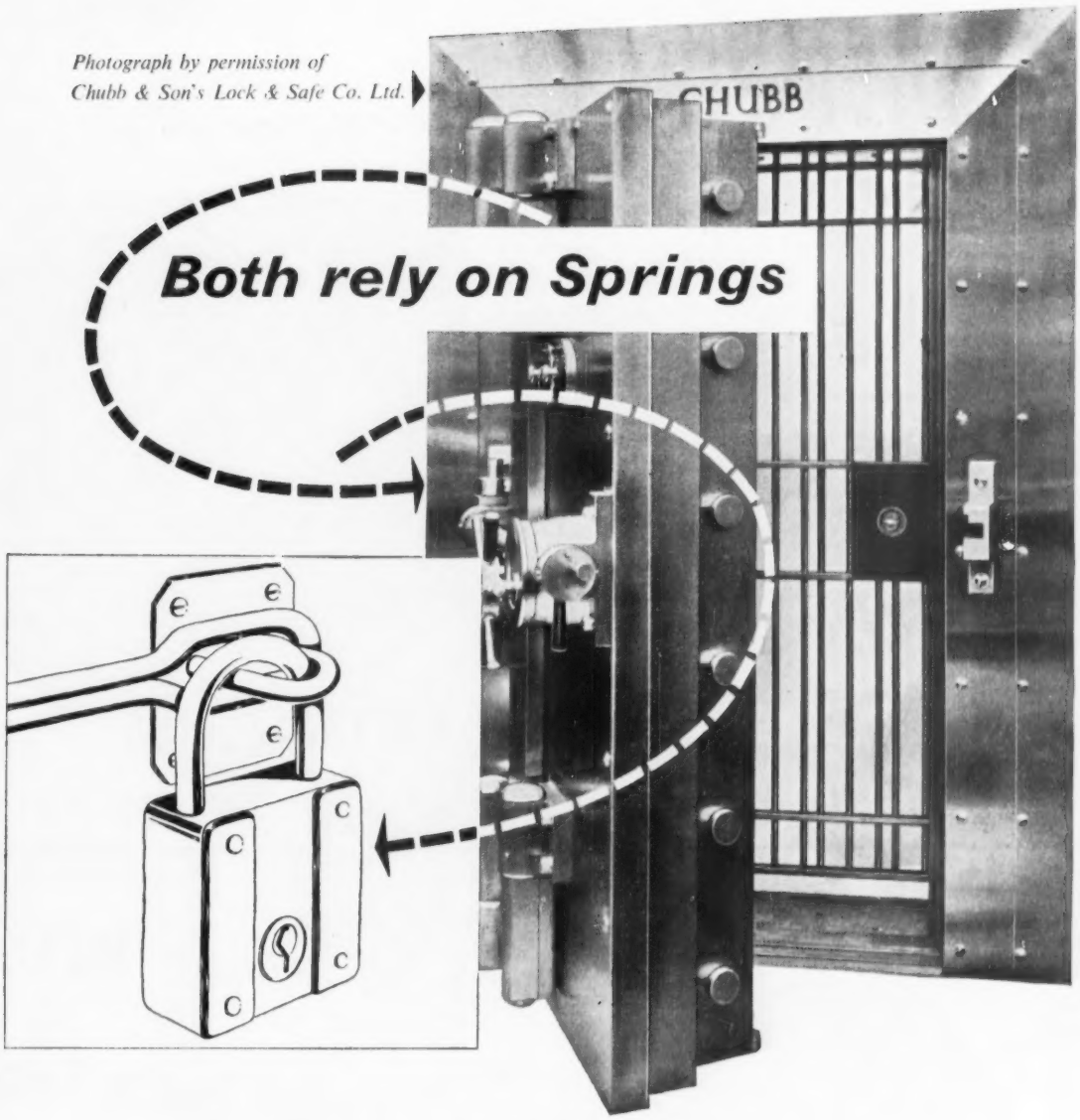

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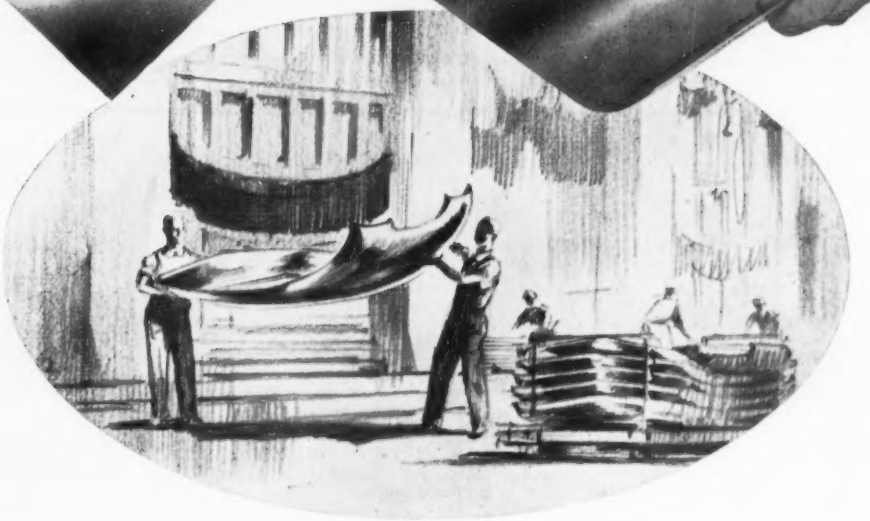

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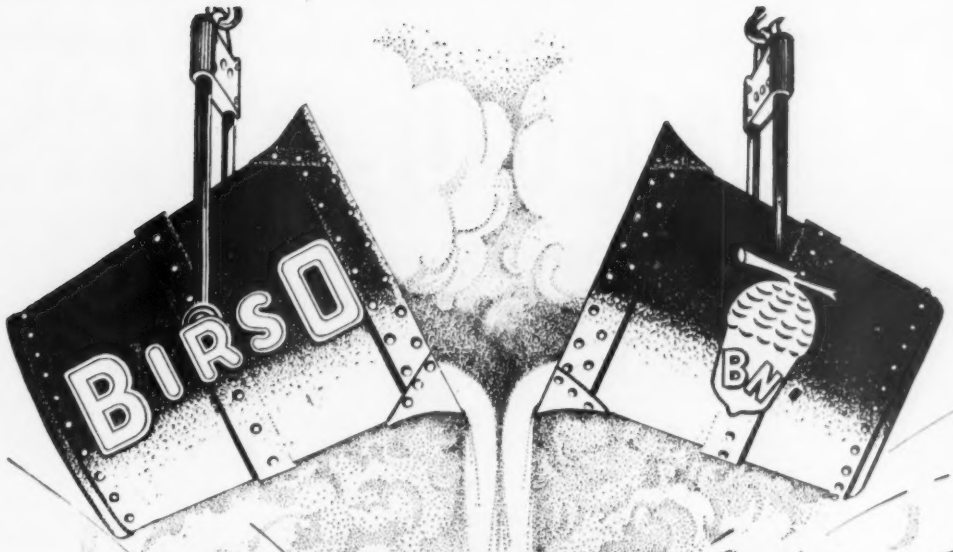

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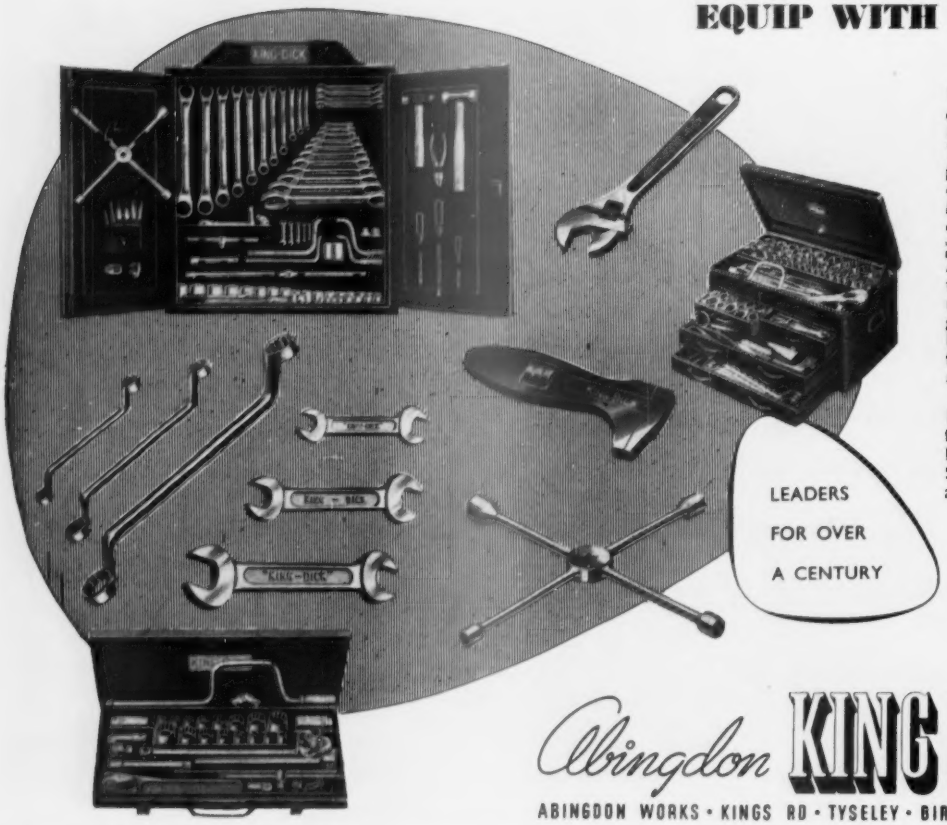

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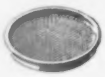
for over 25 years  in the production of filters strainers

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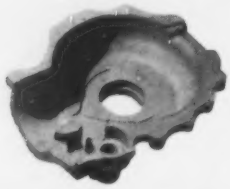

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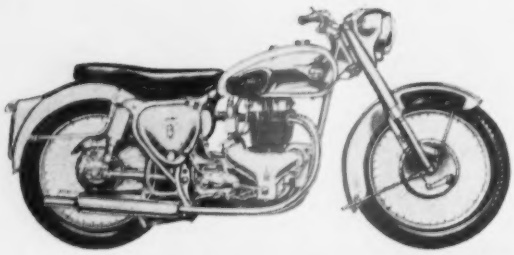

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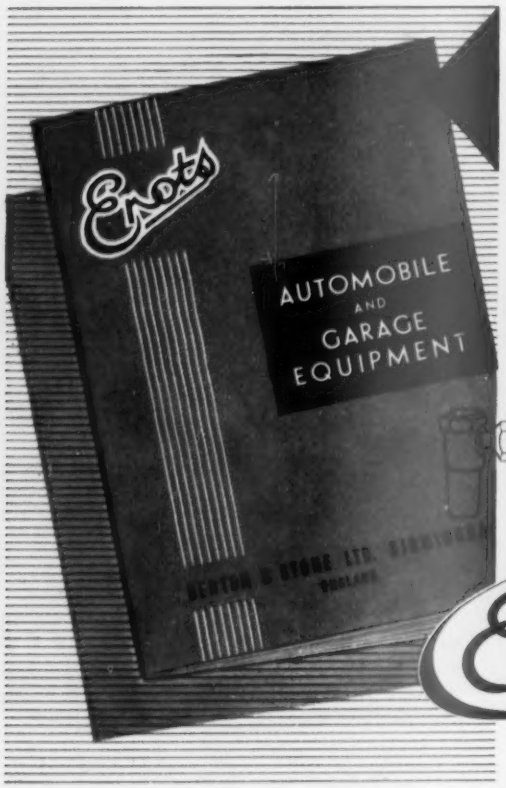

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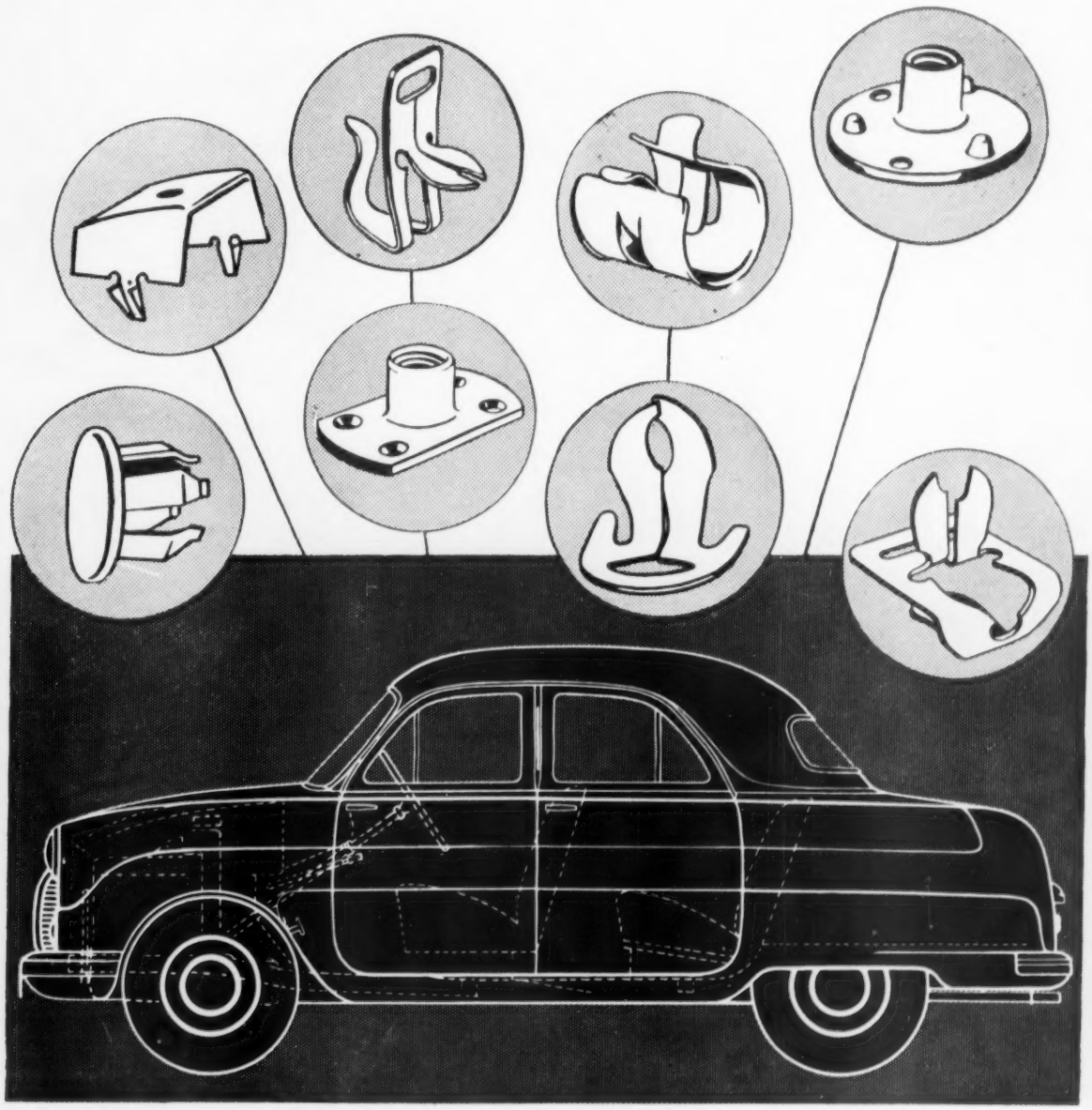

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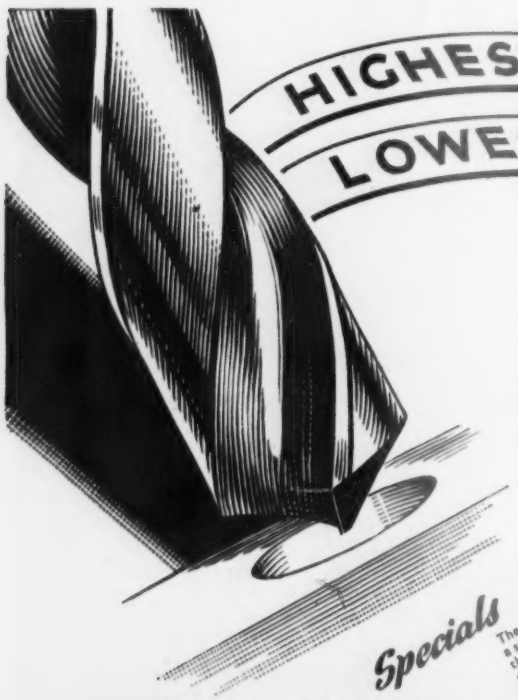

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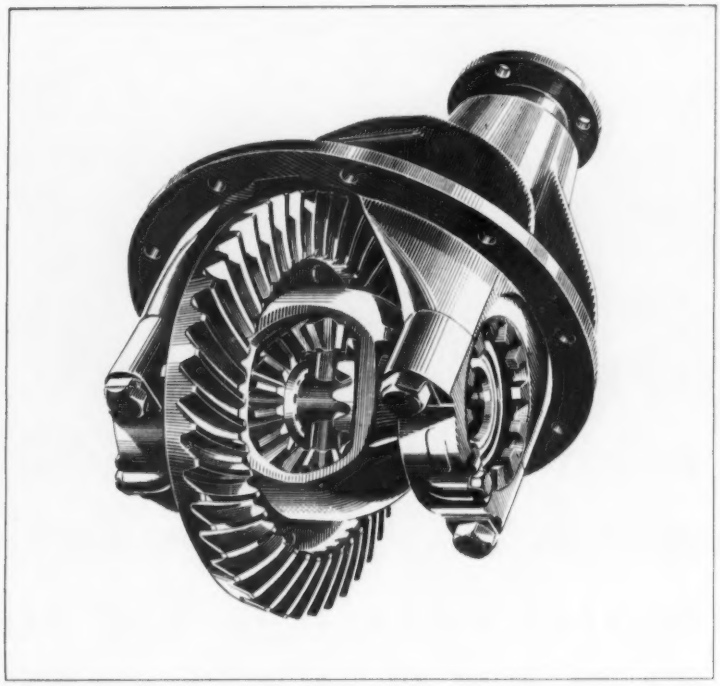

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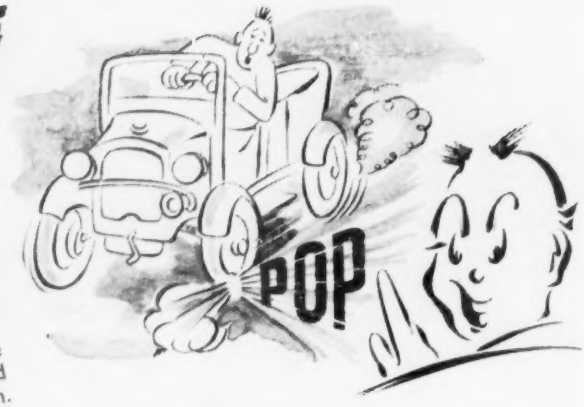

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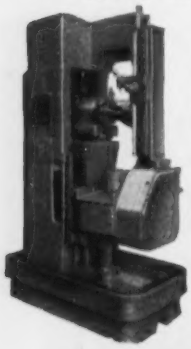

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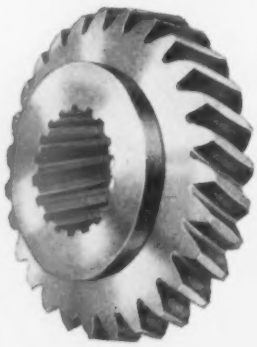

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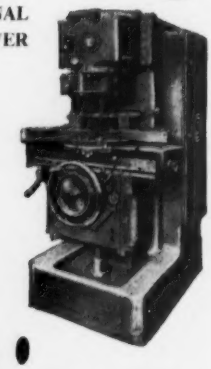

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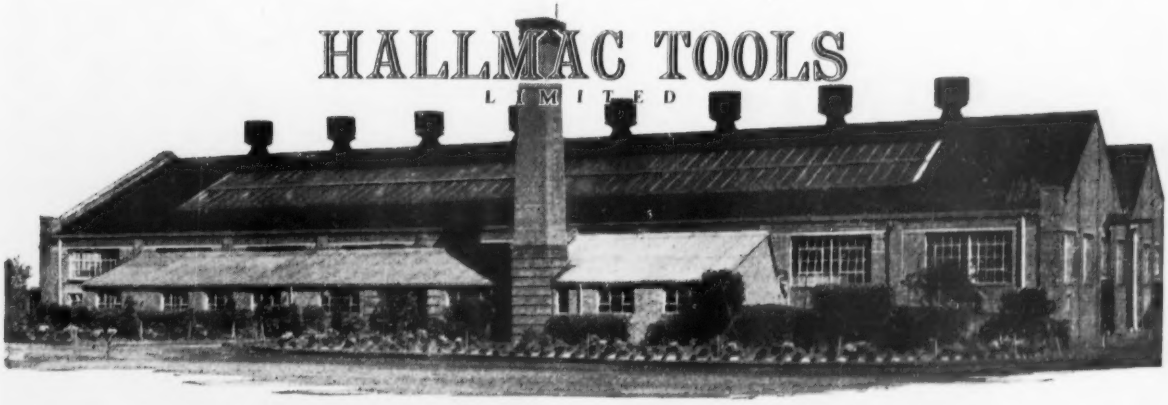

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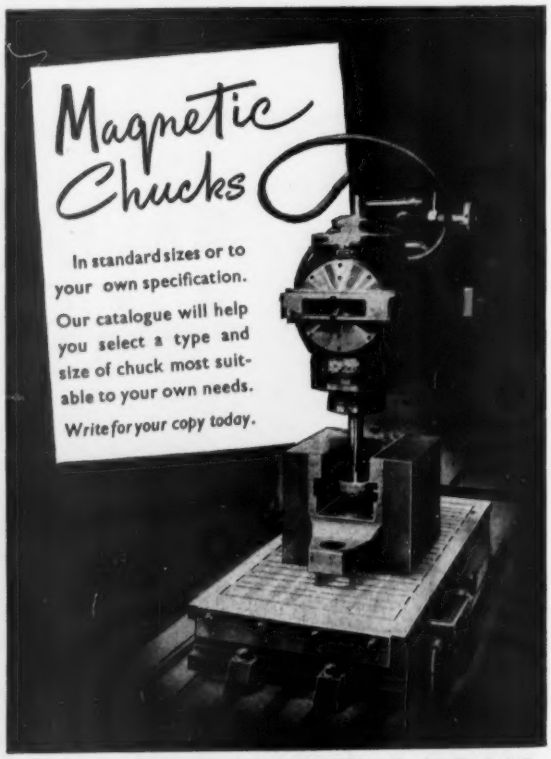

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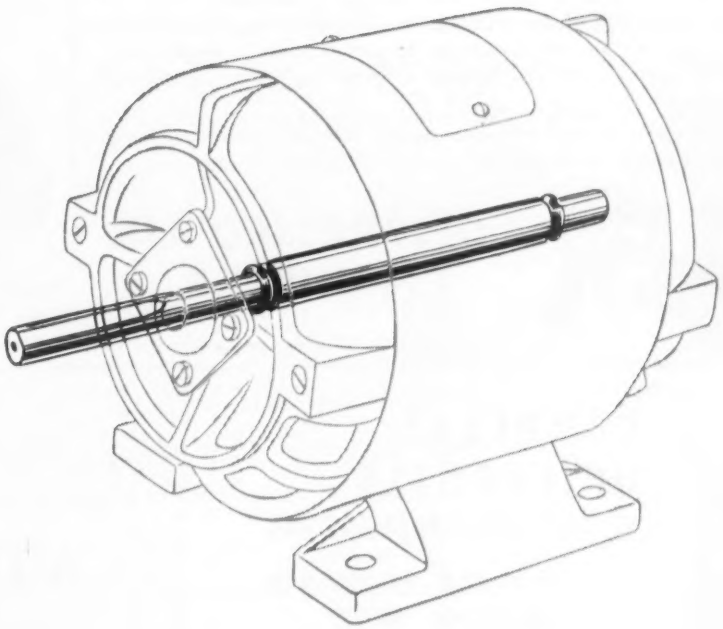

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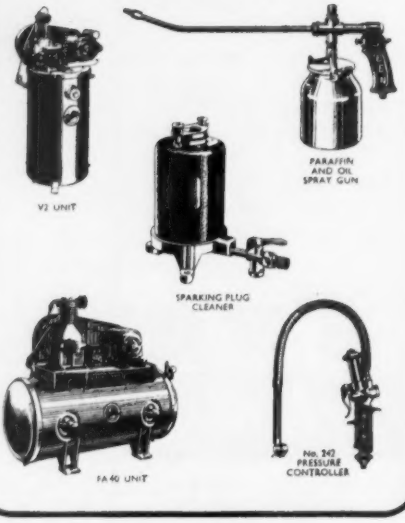

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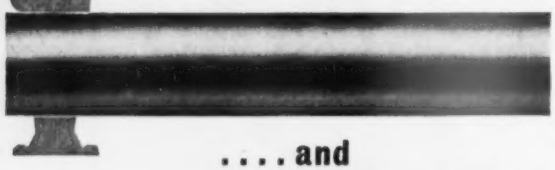

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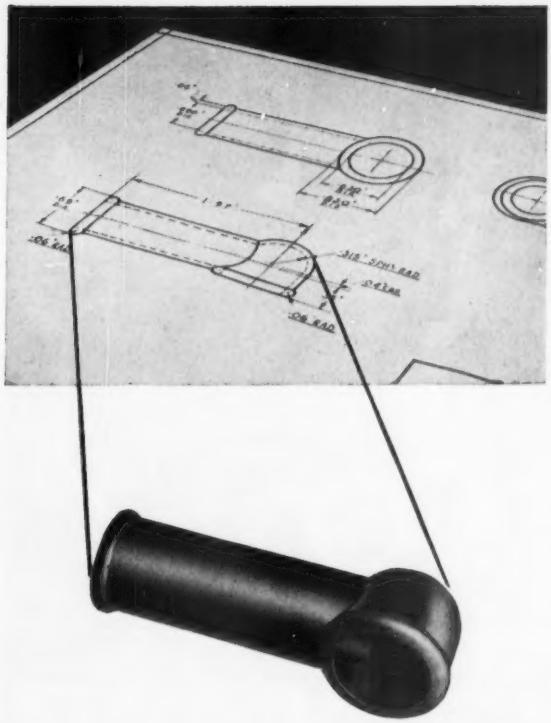

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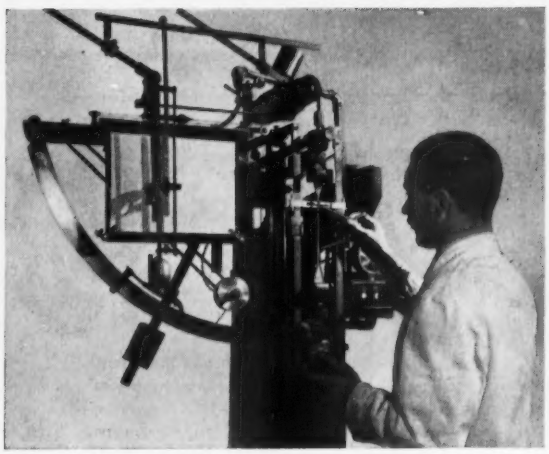

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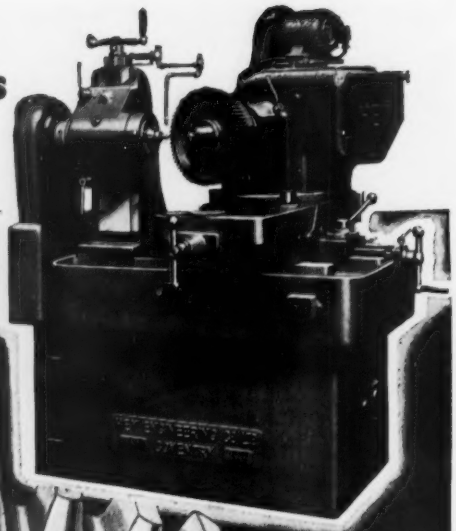

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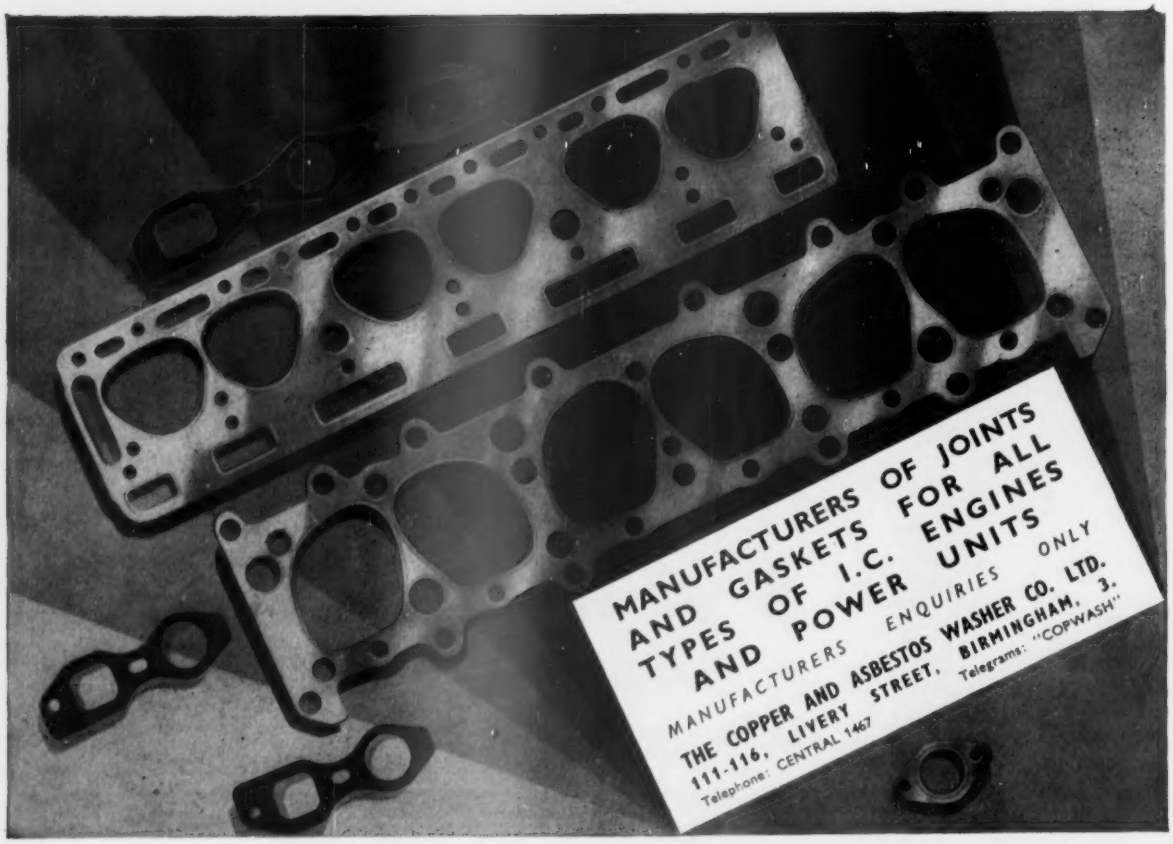
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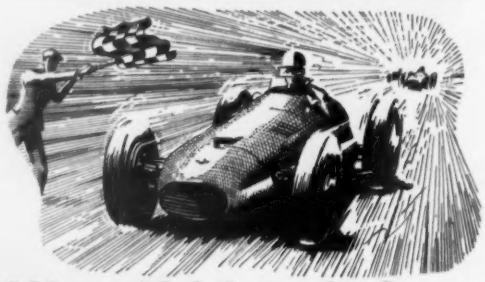

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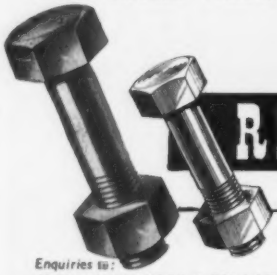

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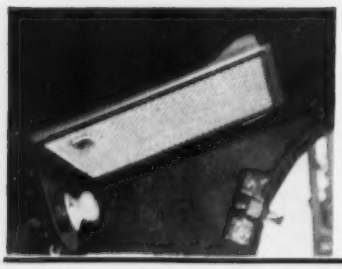

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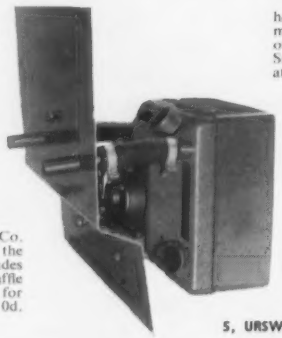

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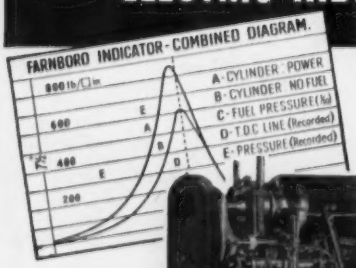

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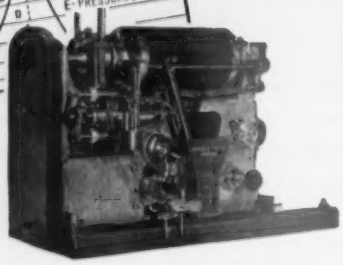

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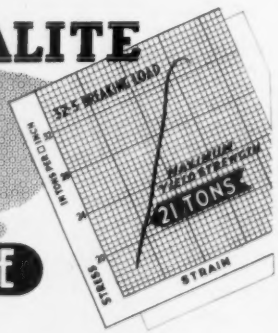

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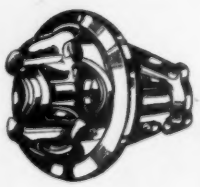

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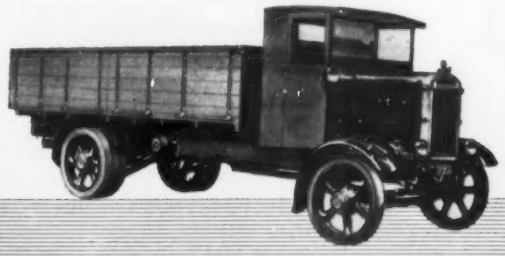

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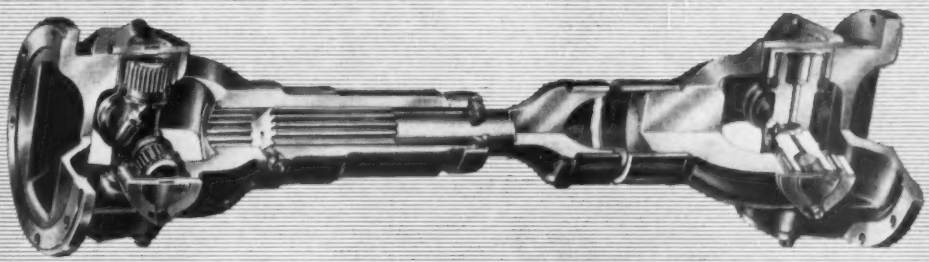

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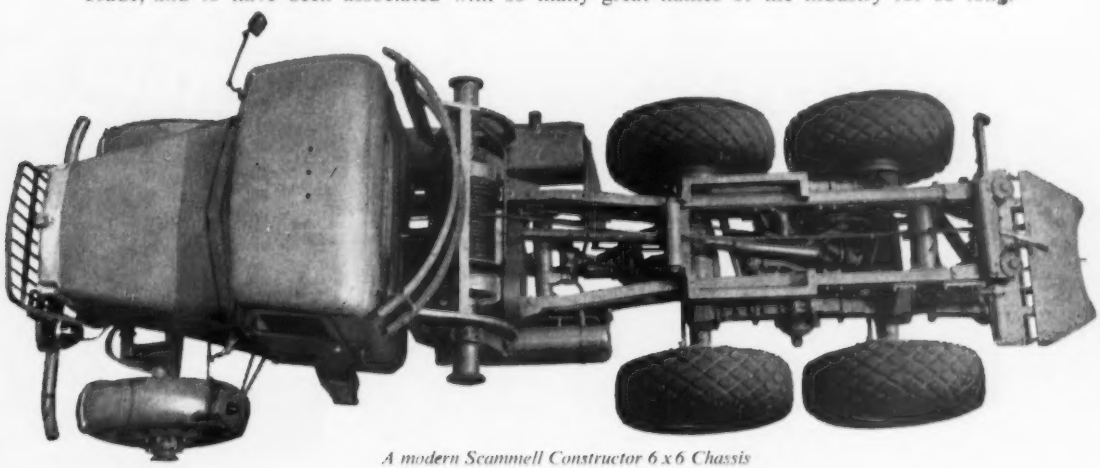

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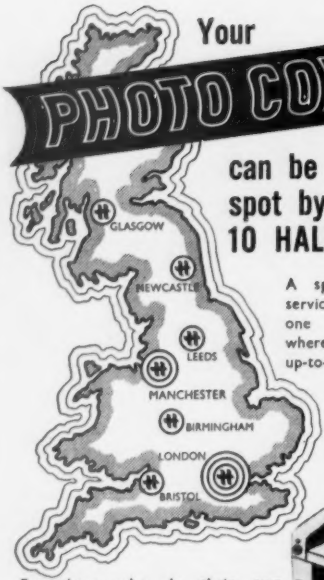

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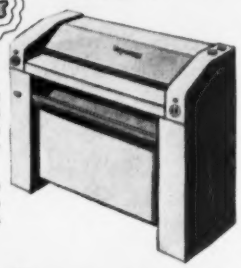

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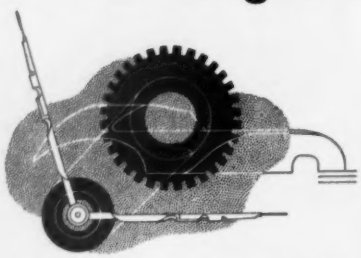

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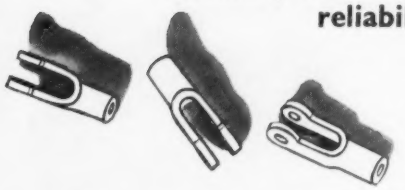

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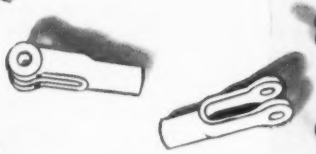

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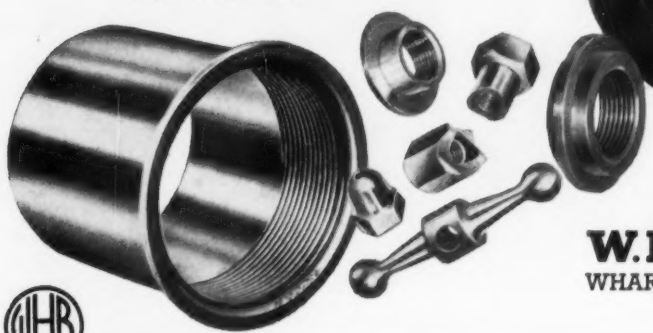

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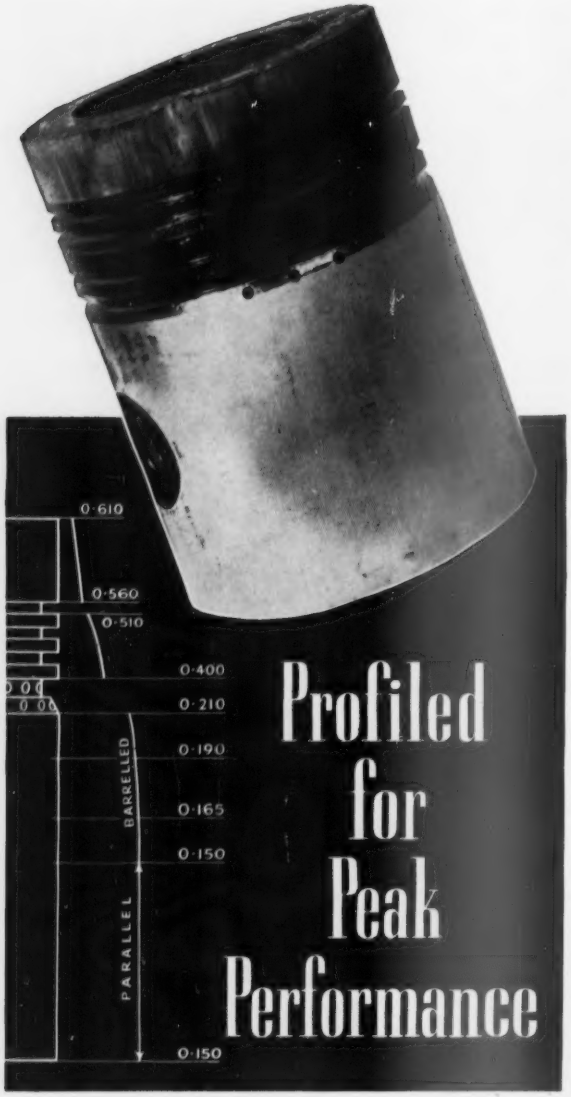

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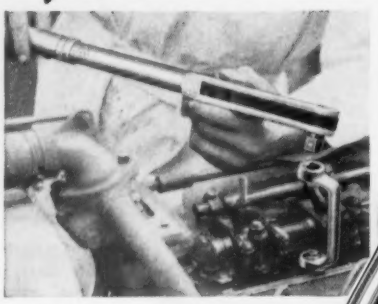

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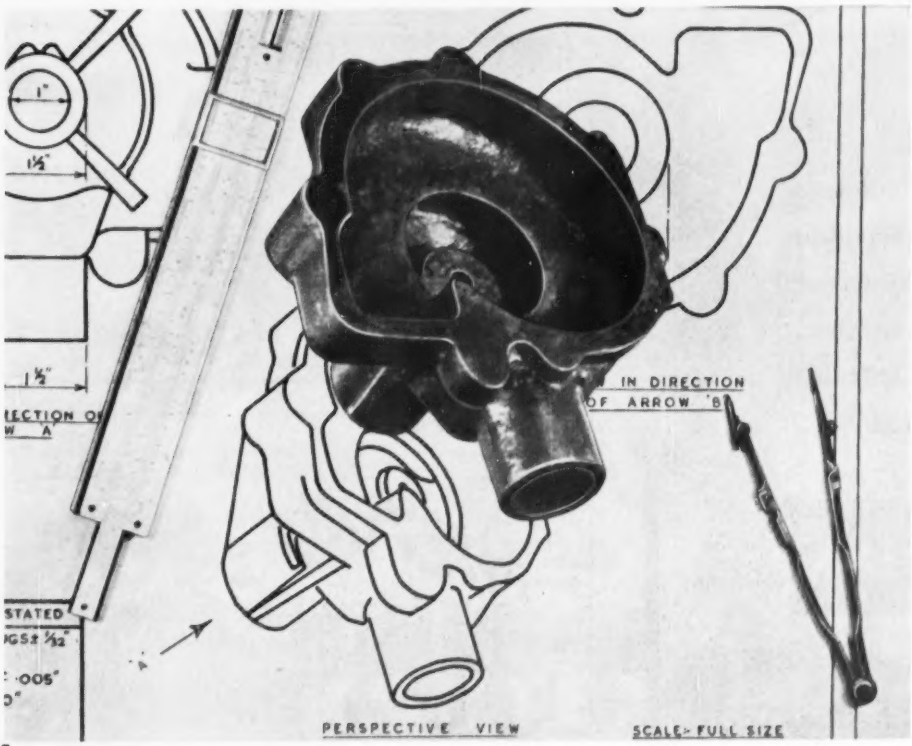

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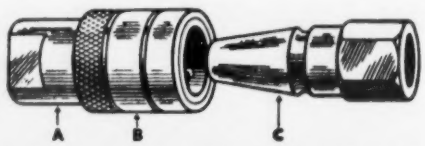

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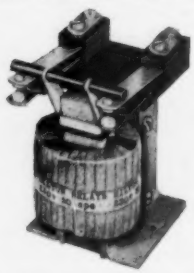

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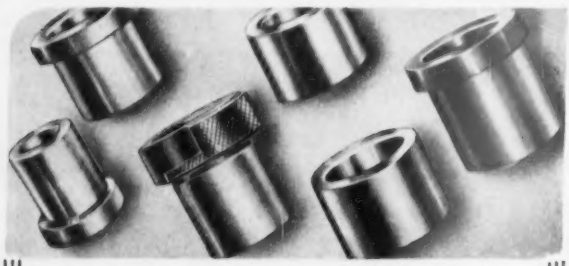

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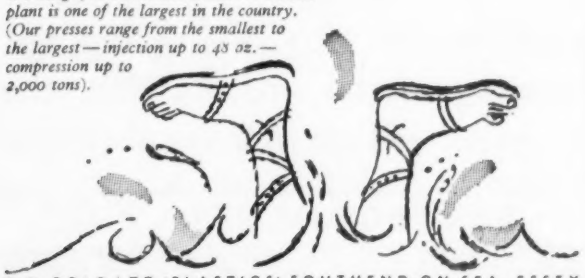

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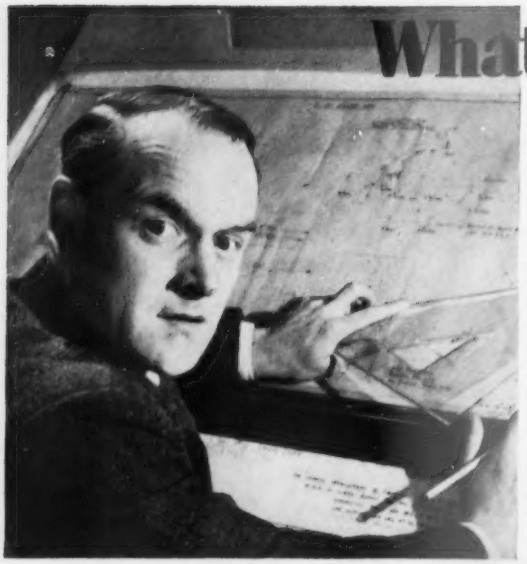

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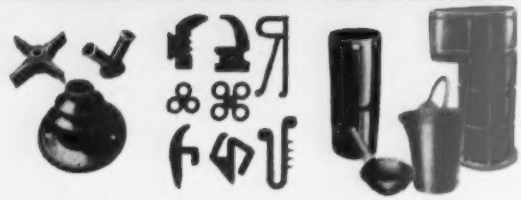

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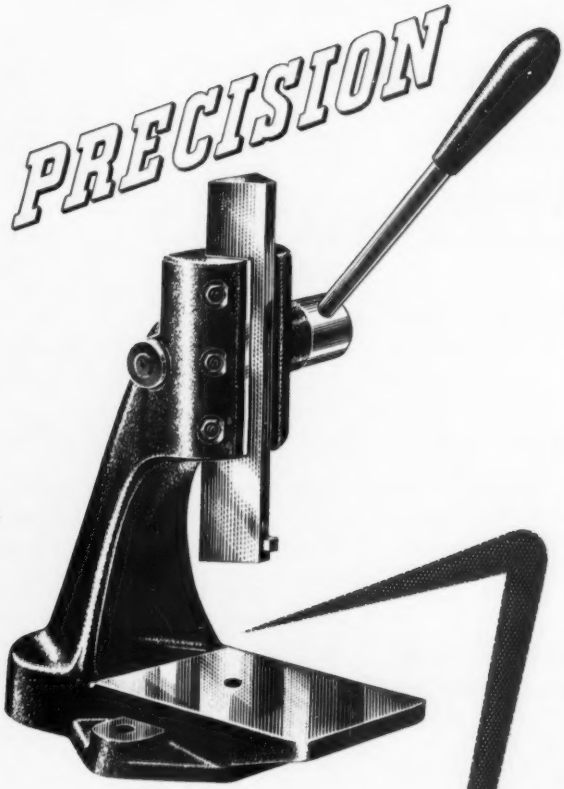

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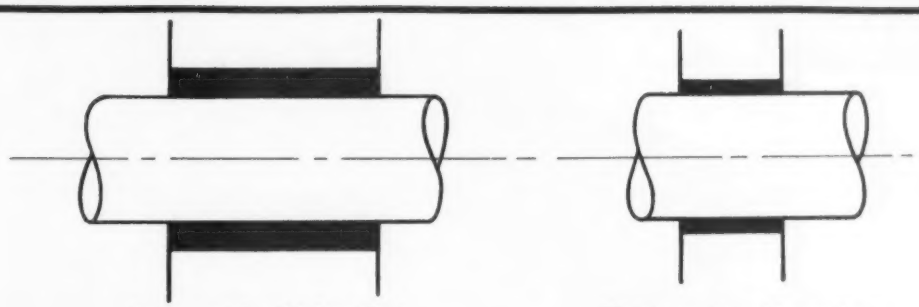

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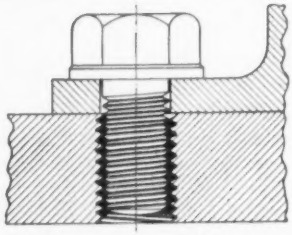

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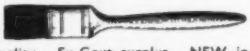

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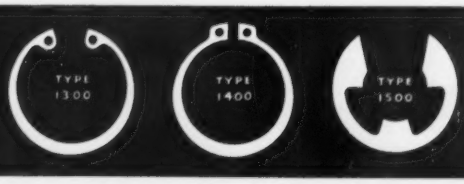

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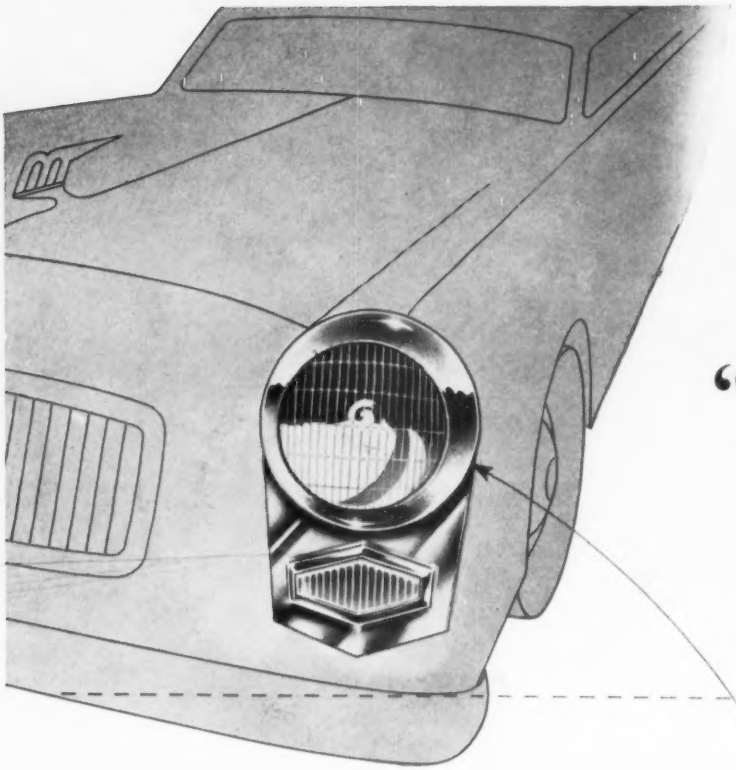

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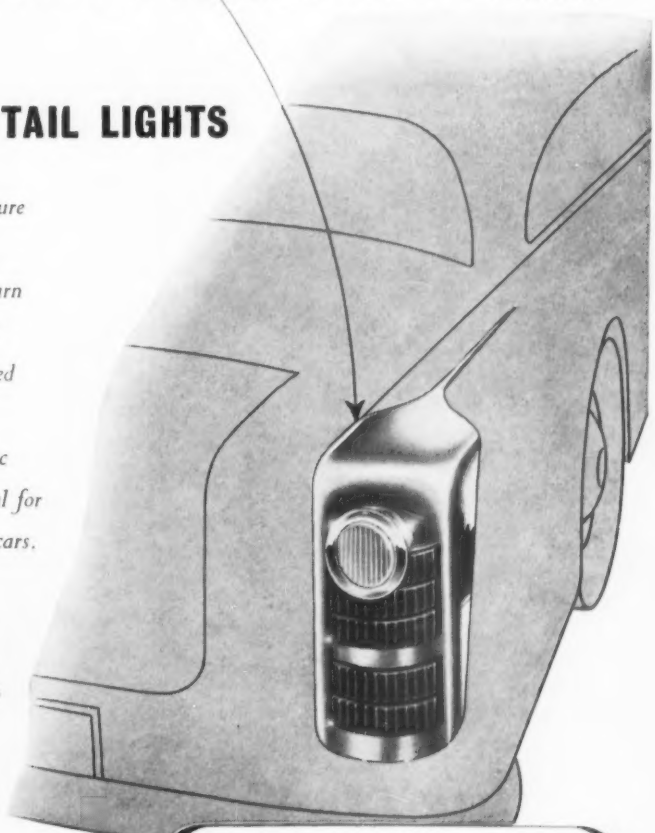

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